Preface

Concept of linear elastic fracture mechanics was first applied to pre-cracked concrete elements in the early 1960s. Thereafter, extensive experimental and numerical research investigations proved that the classical form of linear elastic fracture mechanics cannot be applied to normal size concrete members. From the past research and studies it also became clear that the modified form of linear elastic fracture mechanics or nonlinear fracture mechanics can be useful and powerful tools for the analysis of the growth of distributed cracking and its localization in concrete if the softening behavior of the material is taken into account. The nonlinear fracture models coupled and introduced the tension-softening constitutive law in the fracture mechanics concepts to study the crack initiation and its propagation in concrete and concrete structures.

In due course of time, a number of nonlinear fracture models have been proposed and used to predict the nonlinear fracture behavior of cementitious materials. These are fictitious crack model or cohesive crack model, crack band model, two-parameter fracture model, size-effect model, effective crack model, K_R-curve method based on cohesive force distribution in the fracture zone, double-K fracture model, and double-G fracture model. Fracture mechanics concept introduced energy approach for crack development and its growth which can avoid the unobjectivity in the results, predict the post-peak response with a less complexity and exhibit size-effect behavior. The brittleness of the material can quantitatively be defined and more uniform safety of factors can be achieved in the structural design with the help of fracture mechanics concept.

It is a well-known phenomenon that the fracture parameters of concrete depend on the softening function of concrete, concrete strength, specimen size, specimen geometry, geometrical factors like relative size of notch length and the loading condition. The literature reports extensive numerical and experimental investigation on nonlinear fracture behavior of concrete. All the important nonlinear fracture models are widely applied to characterize the related fracture parameters and these studies are available in scattered literature. This book attempts to present the theoretical development and applications of various nonlinear concrete fracture models in a unified manner using different fracture parameters. In this regard, the authors

investigated the behavior of fracture parameters of concrete at different phases of crack propagation phenomena of concrete.

There are six major chapters in the textbook which are mainly based on the recent research and studies carried out by the authors in the recent years. The detailed introduction of the book is mentioned in the opening chapter. In the subsequent chapters, cohesive crack model for three-point bending test, four-point bending test, and compact tension specimens using important softening functions of concrete are developed. The numerical results are compared with the experimental results available in the literature. Further, a systematic study on the different cohesive crack fracture parameters is carried out. Introduction of weight function method is explained to determine the double-K fracture parameters and the K_R-curve method based on cohesive stress distribution. Furthermore, attempts are made to put forward some new developments regarding behavior of different fracture parameters using the cohesive crack model as the reference. A comprehensive comparison between the double-K and double-G fracture criteria is presented. Emphasis on the effect of various parameters including specimen geometry, size effect, and loading condition on the double-K and the K_R-curve method is also focused. Finally, a comparative study among different fracture parameters obtained from important nonlinear models is presented. Hence, the textbook presents results of a comprehensive study on the crack initiation and its growth in concrete-like materials using various fracture models. At last, the flowcharts of various fracture models are presented in Appendix.

In this book, the authors have taken a small step to present a basic introduction on the various nonlinear concrete fracture models considering the respective fracture parameters. It can be helpful to undergraduate and postgraduate students who are studying this subject. An immense help to the beginners and researchers in the area of fracture mechanics of concrete is expected from this book which will provide a sound basis on the relevant subject to carry out further innovative research work in the future. Appendix can be of much use to the readers for computing different fracture parameters using computer programs.

At last, the authors would be thankful to the readers and their invaluable suggestions or comments for the further improvement of the book.

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