Preface

This book is a result of the authors' research and teaching in the field of finite element nonlinear analysis over many years.

In the research related to this book, our objective has been to develop robust, accurate and efficient computational procedures to calculate stresses from given strains (strain-driven problems) within incremental (finite element) inelastic analyses. To this aim, M. Kojić worked at ADINA R&D, Inc., intermittently, for a few years about 18 years ago. During that time we published together four valuable papers (Bathe et. al. 1984, Kojić and Bathe 1987a, 1987b, 1987c). In these papers we introduced the "effective-stress-function" method for the implicit integration of thermo-elasto-plastic and creep material models. We found that the function of the effective stress (a single parameter which governs the inelastic deformations in the time step) is monotonic, and that the zero provides the solution for the stresses, creep and plastic strains at the end of the time step. The simple algorithm was surprisingly robust, accurate and efficient, and suitable for general applications. Based on the exciting research we had conducted, we formally agreed at that time to write a book together on the inelastic analysis of solids and structures.

Since 1992, M. Kojić no longer contributed at ADINA R&D, but we both continued to work independently on the development of inelastic analysis procedures. M. Kojić published a series of papers in which he called a generalization of the effective-stress-function method the "governing parameter method". Independently, K.J. Bathe continued his research on inelastic analysis procedures and used the effective-stress-function method and generalizations thereof, and ADINA R&D continued to develop material models in ADINA. Of course, some of these material models are the subject of this book.

In teaching, our objective has been to present in a unified manner the physical and theoretical background of inelastic material models and computational methods, and to illustrate the behavior of the models in typical engineering conditions.

With the above objectives we started about five years ago to work on this text. We prepared this book to give the fundamentals of inelastic material models based on experimental observations and principles of mechanics, to describe computational algorithms for stress calculation (stress integration within a time step), and to present solved examples. We give the theoretical background to an extent necessary to describe the commonly employed material models in metal isotropic and orthotropic plasticity, thermoplasticity and viscoplasticity, and the plasticity of geological materials. The computational algorithms are developed in a unified manner with some detailed derivations of the algorithmic relations. The solved examples are designed to give insight into the material behavior in various engineering conditions (general three-dimensional deformations, plane strain, axisymmetric, plane stress, shell, beam, pipe conditions), and to demonstrate the application of the computational algorithms.

In the book we do not focus on some of the current research areas in computational inelasticity, as, for example, non-local models, gradient plasticity theory, damage models, fracture and the dynamics of inelasticity. But the presented computational methods can, of course, be used for the development of algorithms in these and other areas. Also, we do not give a detailed review of computational methods in inelasticity nor a broad presentation of these methods, but rather only focus on our experiences in the field.

We wrote this book for self-study by engineers and students, and for use in graduate courses on computational inelasticity, with emphasis in certain areas. For example, Chapters 1 to 5 can be used in a course devoted to inelastic deformations of metals. In case large strains are also considered, Chapter 7 should also be used. For subjects with emphasis on geological materials, Chapters 1 to 4 and 6 are applicable. Also, certain sections of the book can be used in courses on general plasticity to simply illustrate how inelastic response is computed in practice.

Preparing this text required of us a large effort, and we are grateful to a number of institutions and individuals.

Miloš Kojić is thankful to the Department of Mechanical Engineering of the University of Kragujevac, the Center for Scientific Research of the Serbian Academy of Science and Art and the University of Kragujevac, and the Automobile Institute Zastava, for the support of his research and for the many granted leaves of absence. He is also grateful to Professors Radovan Slavković, Miroslav Zivković, Nenad Grujović, Branislav Popović and Ivo Vlastelica, and Dusan Begović, all of the University of Kragujevac and the PAK-software research and development group, and Srdjan Divac of Harvard University for their collaboration in research and comments on this book. And he thanks, for an extraordinary effort in preparing the figures for this book, Dr. Ivo Vlastelica and Vladimir Djordjević, and for technical support in typing the manuscript Miloš Babović, Vladimir Dimitrijević, Snezana Vulović, Dr. Nebojsa Zdravković, Dr. Nenad Filipović, and Aleksandar and Nikola Kojić.

Klaus-Jürgen Bathe is thankful to the Department of Mechanical Engineering, M.I.T, for the excellent environment made available for his teaching and scholarly writing. This book required a large amount of his time, with much strenuous effort. However, the book has now reached a level, where

he would like to see it published. K.J. Bathe is grateful to his many students and colleagues who have worked with him over many years. Regarding this book, he is particularly thankful to his student Phill-Seung Lee, to Professor Francisco J. Montáns, University Castilla La-Mancha, Spain, and to Professor Jay Wang, Louisiana Tech University, Ruston, Louisiana, for their comments, and to Dr. Song Wang of ADINA R&D, Inc. for his help in the example solutions. He would like to acknowledge as well that – to improve his teaching and research efforts – his involvement in ADINA R&D has been very valuable.

Finally, we would like to thank our families for their continuous support and understanding regarding our scientific endeavors.

M. Kojić and K. J. Bathe

Springer
http://www.springer.com/978-3-540-22793-9

Inelastic Analysis of Solids and Structures
Kojic, M.; Bathe, K.-J.
2005, XII, 420 p. 136 illus., Hardcover
ISBN: 978-3-540-22793-9