

Computational Plasticity

in Powder Forming Processes

Amir R. Khoei

The application of computer-aided engineering is essential in modern metal forming technology. Process modeling for the investigation and understanding of deformation mechanics has become a major concern in research, and the finite element simulation has assumed increased importance, particularly in the modeling of powder forming processes.

The main purpose of this book is to present the fundamentals and applications of finite element plasticity in powder forming analysis and technology. The book focuses on specific areas, such as large deformation, including: Lagrangian and arbitrary Lagrangian-Eulerian formulation, classical and modern constitutive theories, such as single-surface, double-surface and multi-surface plasticity models, endochronic plasticity theory, continuum model of frictional phenomena, a finite strain plasticity based on hypoelasto-plastic model, and finally, the presentation of pre- and post-processing of powder compaction software (PCS_SUT).

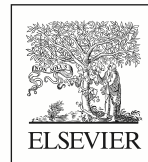


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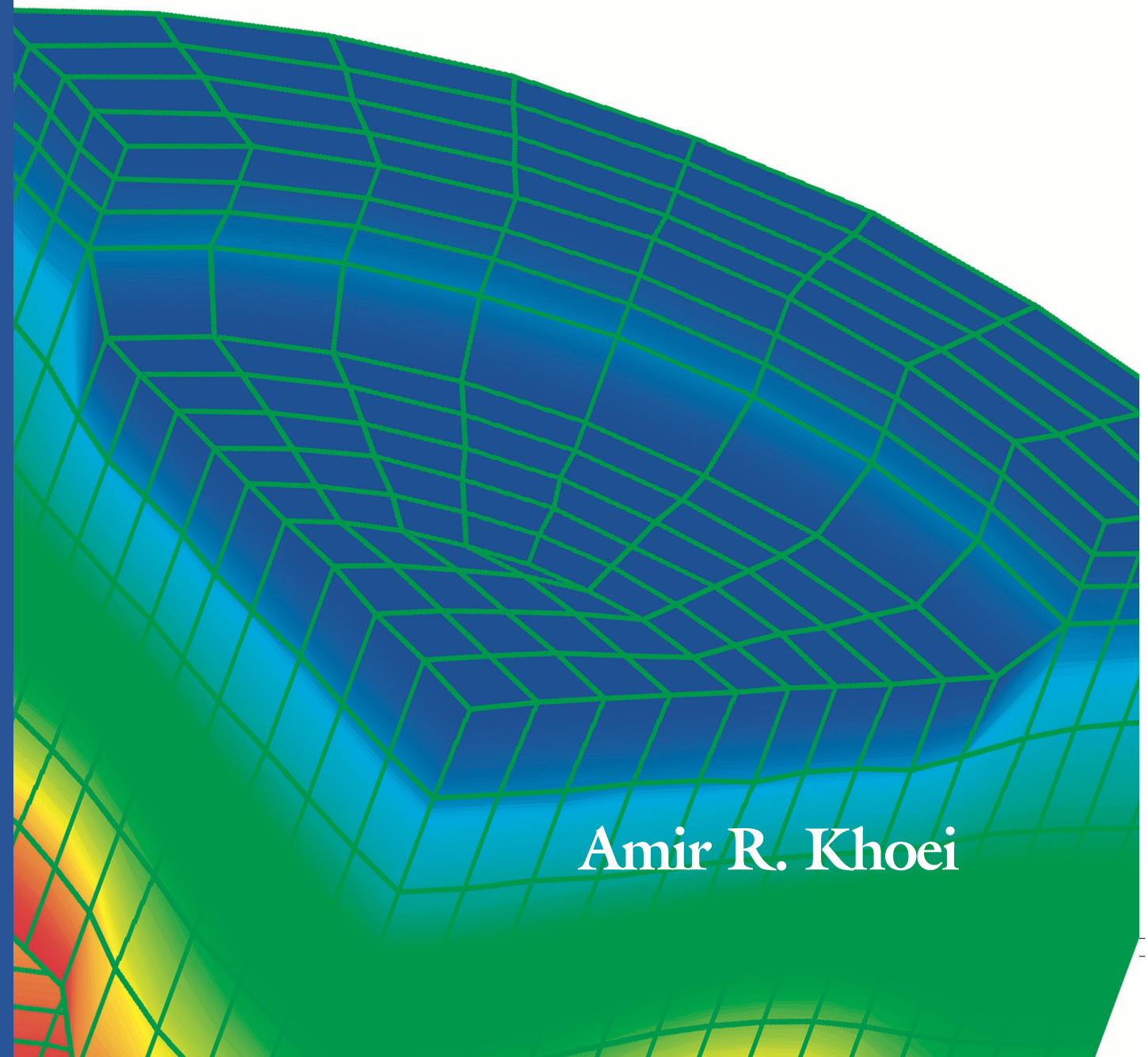
Khoei



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Amir R. Khoei

Associate Professor

Civil Engineering Department
Sharif University of Technology
P.O. Box 11365-9313
Tehran
Iran

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*To my wife and son
Azadeh and Arsalan*

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PREFACE

The application of computer-aided engineering is essential in modern metal forming technology. Process modeling for the investigation and understanding of deformation mechanics has become a major concern in research, and the finite element method has assumed increased importance, particularly in the modeling of powder forming processes. The finite element method emerges as the preferred approach and its flexibility leads to the development of powerful program packages capable of treating wide range of problems. The FE analysis provides detailed information on conditions within the processed material, which is often more complete than can be obtained even from elaborate physical experiments, and the numerical simulation makes it possible to examine a range of designs, or operating conditions economically. The main purpose of this book is to present the fundamentals and applications of finite element plasticity in powder forming analysis and technology.

The book is primarily written for graduate students and researchers (Masters and PhD students in Mechanical, Materials, Civil and Chemical Engineering). However, it will be useful to practicing engineers who have a good background in FEM and who are interested in applying this technique to the analysis of metal forming processes.

The book begins with a general background on the subject in Chapter 1. A general description of the governing equations for large deformation process of metal powder forming is given in Chapter 2 based on the Lagrangian and arbitrary Lagrangian-Eulerian formulation. Chapter 3 describes the mechanical behavior of powder materials using classical and modern constitutive theories. A combination of a Mohr-Coulomb and hardening cap model, a generalized double-surface plasticity and a three-invariant single plasticity theory are developed in this chapter in the concept of the generalized plasticity formulation. In Chapter 4, the general problem of formulating continuum models for frictional phenomena and of developing computational methods for analyzing these phenomena is introduced. Chapter 5 illustrates the applicability of the cap plasticity in simulating powder forming processes. Chapter 6 is devoted to the application of adaptive FEM strategy in the analysis of powder forming processes. In chapter 7, a new approach is developed based on an endochronic density-dependent plasticity model for describing the isothermal deformation behavior of powder materials. An application of the multi-surface plasticity theory is presented for pressure-independent and pressure-dependent materials in this chapter. In chapter 8, the numerical modeling of powder forming process is simulated by a finite strain plasticity based on hypoelasto-plastic formulation. Chapter 9 presents 2D and 3D numerical modeling of powder forming process using advanced plasticity models. In chapter 10, a computational algorithm is presented for dealing with softening plasticity due to material instability. Finally, the powder compaction software (PCS_SUT), which is designed for pre- and post-processing for computational simulation of the process compaction of powder is presented in Chapter 11.

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Amir R. Khoei