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Finite Element Method in Machining Processes

Springer

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Preface

The finite element method is a powerful tool with applications in many industrial sectors. Manufacturing and especially machining is not an exception. Since the early 1970s it has provided valuable information on fundamental understanding of the material removal process but more importantly predictive models that can provide reliable results on many machining parameters. As a modeling method it has proven superior and by far more versatile than any other. The vast number of publications, pertaining to machining, and finite element analysis, proves it.

This Springer Brief aims to provide information on the modeling of machining processes by the finite element method. In Chap. 1 an introduction to machining and especially metal cutting is provided. Some basic features of turning, milling, and drilling are discussed and the terminology that is used throughout the book is introduced. Chapter 2 gives a description of orthogonal and oblique cutting, two schemes very popular among the machining researchers. A discussion on analytical modeling of machining is provided in this chapter. Shear plane, Slip-line field, and shear zone models are discussed. This is a helpful introduction to machining modeling. Chapter 3 is dedicated to finite element method. The features to be implemented in a FEM model are described and the most popular approaches are discussed. In this chapter, numerical formulation, mesh, elements, boundary conditions, and contact considerations are analyzed. Furthermore, material and friction modeling are considered and a discussion on chip separation and breakage criteria and adaptive meshing is provided. From all these numerical considerations and the research conducted so far it may be said that there is not a single solution that is acceptable on how the "perfect model" looks like. The search goes on with new ideas and better tools. The researchers' arsenal stores better understanding of machining, more powerful computers, and special software. At the end of this Chapter a bibliographical review is provided along with a brief presentation of commercial FEM software. Chapter 4 is the part of the book where examples of finite element models are given. Three areas, namely high speed machining, 3D modeling, and micromachining, are selected. For each area, a discussion on the work done so far and how the models overcome problems that may arise is provided. Chapter 5 is the last one, where the modeling techniques for other machining operations are described. More specifically, grinding is considered here and a paragraph for non-conventional machining and machining of composite materials is squeezed in. Furthermore, soft computing techniques, molecular dynamics, and meshless methods for machining are presented.

The book is by no means complete, in the sense that for every topic included a lot more can be added. The reader who starts now to get acquainted with FEM models of machining can raise his awareness of what lies ahead of him. The experienced user may review the advancements through all the past years and get new ideas to move on or use it as a reference book.

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Angelos P. Markopoulos

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