CONTENTS

Foreword xi
Preface xiii
Acknowledgments xv
Author xvii

Chapter 1
Introduction 1
1.1 Objectives of the Book 1
1.2 Basics Concepts of FEM 1
1.3 Basic Steps of All Engineering Software, Based on FEM 2
1.4 SW Simulation as a Package for FEA 3

Chapter 2
Development of a Finite Element Model of a Body (Pre-Processor Stage) 5
2.1 Description of Functions of Physical Model 5
2.2 Development of the Geometrical Model in SolidWorks 6
2.3 Some More Perquisite Knowledge before Development of SW Simulation Model 15
2.3.1 Main Features of Linear Static Analysis 15
2.3.2 Starting SolidWorks Simulation 16
2.3.2.1 Activate SW Simulation Toolbox 16
2.3.2.2 Open the CAD Model 17
2.3.2.3 Getting Access to Help Files 18
2.4 Introducing the Material of the Body 26
2.4.1 How SW Simulation Handles Material Properties 26
2.4.2 Defining the Material of the Chisel 30
2.5 Introducing the Fixtures to the Body 31
2.5.1 Different Fixtures Supported by SW Simulation 31
2.5.2 Defining the Fixtures to the Chisel 37
2.6 Introducing the Loads to the Body 39
2.6.1 Different Structural Loads, Which Can Be Introduced by SW Simulation 39
2.6.2 Defining the Loads to the Chisel 43

Chapter 3
Development of a Finite Element Model of a Body (Processor Stage) 49
3.1 How Does Finite Element Analysis Work? 49
3.2 What Are the FEs and the Mesh? 50
3.3 Meshing of the Analysed Body 58
3.4 Running the FEA 60

Chapter 4
Visualising and Systematising the Results of FEA (Post-Processor Stage) 65
4.1 Setting the Analysis and the Results Preferences 65
4.2 Different Ways to Systematise and Plot the Results of FEA 75
4.2.1 Results Display through Simulation Advisor 75
4.2.2 Results Display through Results Folder in the Analysis Tree 85
4.2.3 Results Display through Icons on the SW Simulation Command Bar 111
4.3 Listing the Results of the Analysis 117
4.4 Drawing Graphs of the Analysis Results 123

Chapter 5
Impact of Mesh Density and Viewing Mode on Final Results 129
5.1 Different Types of FEs, Regarding the Geometry of the Model 129
5.2 Impact of Mesh Density, When Standard Solid Mesh Is Used 132
5.2.1 Coarse Mesh Calculations 132
5.2.2 Fine Mesh Calculations 135
5.2.3 Control Mesh Calculations 137
5.2.4 Comparison of Results and Conclusions 142
5.3 Impact of Mesh Density, When Curvature-Based Solid Mesh Is Used 146
5.3.1 Development of CAD Model of Hole Puncher 146
5.3.2 Development of Hole Puncher Model – Pre-Processor Stage 148
5.3.3 Coarse Mesh Calculations 150
5.3.3.1 Scenario 1 150
5.3.3.2 Scenario 2 151
5.3.4 Fine Mesh Calculations 153
5.3.5 Control Mesh Calculations 155
5.3.5.1 Scenario 3 155
5.3.5.2 Scenario 4 158
5.3.6 Comparison of Results and Conclusions for Curvature-Based Mesh 160
5.4 Impact of Mesh Density on Calculation Time and Accuracy 163
5.5 Comparison between the Node Mode and the Element Mode 165
5.6 Final Recommendations on Selection of Mesh Type 165

Chapter 6
Static Analysis of Solid Body with Circular or Planar Symmetry 167
6.1 Development of CAD Models of the Analysed Bodies 167
6.1.1 Geometrical Model of a Body with Circular Symmetry 167
6.1.2 Geometrical Model of a Body with Planar Symmetry 177
6.2 Static Analysis of the Designed Symmetrical Machine Unit with Circular Symmetry 189
6.2.1 Why Use Symmetry and How It Works 189

6.2.2 Defining the Analysed Segment 191
6.2.3 Static Study of a Body with Circular Symmetry and Symmetrical Loads 194
6.2.4 Static Study of a Body with Circular Symmetry and Anti-Symmetrical Loads 204
6.3 Static Analysis of the Designed Symmetrical Machine Units with a Planar Symmetry 207
6.3.1 Defining the Analysed Segment 207
6.3.2 Static Study of a Body with Planar Symmetry and Symmetrical Loads 207

Chapter 7
Static Analysis of a Shell Body 223
7.1 When Can an Object Be Treated as a Shell? Thin or Thick Shell FEs? Different Approaches for FEA of a Shell in SW Simulation 223
7.2 Development of a CAD Model of a Shell Using Surface Tool (Surface.sldprt) 224
7.3 FEA of a Shell, Created Using Surface Tool (Surface.sldprt) 228
7.3.1 Pre-Processor Modelling of the Object 228
7.3.2 Meshing the Shell 232
7.3.3 Viewing the Results 234
7.4 Development of a CAD Model of a Shell Using Sheet Metal Tool (Sheet_Metal.sldprt) 237
7.5 FEA of the Shell, Created Using Sheet Metal Tool (Sheet_Metal.sldprt) 244
7.6 Comparison of the Results from the Two Case Studies 246

Chapter 8
Static Analysis of a Frame Body 251
8.1 Beams or Trusses? 251
8.2 Development of a CAD Model of a 3D Frame 254
8.3 Calculation of a 3D Frame of Trusses 259
8.3.1 Pre-Processor and Processor Stages 259
8.3.2 Viewing the Results 263
8.4 Calculation of a 3D Frame of Beams 265
8.4.1 Pre-Processor and Processor Stages 265
8.4.2 Viewing the Results 271
8.4.3 FE Analysis, When There Are Hinge Connections at Both Ends of All Beam Members 274

Chapter 9
Static Analysis of a Complex Structure 281
9.1 CAD Model of the Studied Structure 281
9.2 Static Finite Element Analysis of the Structure 288
9.3 Comparison of the Results of the Sixth Design Scenarios 306
9.3.1 Definition of Stress Plots 306
9.3.2 Definition of Plots of Inner Beam Forces 311
9.3.3 Definition of Displacement Plots 312
9.3.4 Definition of Deformation Plots 314

Index 327