

CONTENTS

Preface	xiii
Introduction	xv
 <i>Chapter 1</i> CUTTING DIES	 1
1.1 Basic Theory of Cutting Sheet Metal	1
1.1.1 Clearance	3
1.1.2 Springback	5
1.2 Formulas for Sheet Metal Cutting Dies	5
1.2.1 Cutting Force for Dies with Parallel Edges	5
1.2.2 Cutting Force for Dies with Bevel-Cut Edges	7
1.2.3 Stripping Force	9
1.3 Cutting Operations	10
1.3.1 Blanking Operation	10
1.3.2 Punching Operation	11
1.3.3 Other Sheet Metal Cutting Operations	11
1.4 Types of Cutting Dies	17
1.4.1 Blanking Dies	17
1.4.2 Punching Dies	20
 <i>Chapter 2</i> FORMING DIES	 23
2.1 Basic Theory of Forming Sheet Metal	23
2.1.1 Terminology	23
2.1.2 Metal Flow	25
2.1.3 Springback	26
2.1.4 Bend Radius	29

2.2	Formulas for Sheet Metal Forming Dies	29
2.3	Forming Operations	38
2.4	Types of Bending and Forming Dies	41
2.4.1	Bending Dies	41
2.4.2	Forming Dies	43

Chapter 3	DEEP DRAWING DIES	47
------------------	--------------------------	-----------

3.1	Basic Theory of Sheet Metal Drawing	47
3.1.1	Metal Flow	47
3.1.2	Wall Thickness	51
3.1.3	Drawing Defects	53
3.2	Formulas for Sheet Metal Drawing Dies	53
3.2.1	Drawing Ratio	54
3.2.2	Blank Diameter	54
3.2.3	Allowance for Trimming	58
3.2.4	Clearance	58
3.2.5	Percent Reduction	59
3.2.6	Drawing Force	60
3.2.7	Blankholder Force	61
3.3	Drawing Operations	61
3.3.1	Cupping Drawing	62
3.3.2	Box Drawing	64
3.3.3	Ironing	65
3.4	Types of Deep Drawing Dies	65
3.4.1	Drawing Dies for Single-Action Press	66
3.4.2	Drawing Dies for Double-Action Press	67
3.4.3	Redrawing Dies	68
3.4.4	Drawing Dies for Conical Shapes	69

3.4.5	Drawing Die for Spherical Shapes	71
3.4.6	Ironing Dies	73

Chapter 4 MISCELLANEOUS TYPES OF DIES 75

4.1	Trimming Dies	75
4.2	Shaving Dies	76
4.3	Curling Dies	77
4.4	Bulging Dies	77
4.5	Necking Dies	79
4.6	Extruding Dies	79
4.7	Compound and Combination Dies	80
4.8	Side-Cam Dies	81
4.9	Progressive and Transfer Dies	83

Chapter 5 BASIC DIE COMPONENTS 85

5.1	Die Set	85
5.1.1	Upper and Lower Shoes	86
5.1.2	Guide Posts and Bushings	86
5.2	Die Block and Punching Units	87
5.2.1	Die Block	88
5.2.2	Punching Units	88
5.3	Stripper, Blankholder, and Knockout Device	90
5.3.1	Stripper	90
5.3.2	Blankholders	93
5.3.3	Knockout System	94
5.4	Heel and Key	96
5.5	Pilots and Gages	97
5.6	Stop Block, Dowels, and Screws	99

Chapter 6	DIE DESIGN TECHNIQUES	101
6.1	General Design Guide Lines	101
6.2	Design of Die Components	102
6.2.1	Design of Drop-Thru Die Blocks	102
6.2.2	Design of Return Die Blocks	104
6.2.3	Design of the Punches	109
6.2.4	Design of the Strippers	115
6.2.5	Design of the Knockouts	122
6.2.6	Design of Gage Components	124
6.2.7	Design of Chutes	126
6.2.8	Design of Die Sets	128
6.2.9	Lifting and Handling Dies	134
Chapter 7	DIE-MAKING PRACTICE	137
7.1	Integrate CAD/CAM Systems for Die-Making	138
7.1.1	What Makes Integrate CAD/CAM Systems Ideal for Die Makers?	138
7.1.2	How Does Integrate CAD/CAM Work?	139
7.2	EDM Machining	142
7.2.1	Ram EDM	142
7.2.2	Small-Hole EDM Drilling	143
7.2.3	Wire EDM	144
7.3	Wire EDM Practice	147
Chapter 8	MATERIALS USED IN DIE-MAKING	155
8.1	Carbon and Alloy Steels	155
8.1.1	Carbon Steels	156
8.1.2	Alloy Steels	158

8.1.3	Designation for Carbon and Alloy Steels	159
8.1.4	Machinability of Steels	160
8.2	Tool and Die Steels	161
8.2.1	Designations and Classification of Tool and Die Steels	161
8.2.2	Characteristics and Applications of Tool and Die Steels	163
8.3	Miscellaneous Materials for Die-Making	167
8.3.1	Cast Iron	167
8.3.2	Cast Steel	169
8.3.3	Materials for Producing Low-Cost Dies	171
 Chapter 9 HEAT TREATMENT OF DIE MATERIAL		173
9.1	Basic Definition of Mechanical Properties	173
9.2	Heat Treatment of Die Materials	174
9.2.1	Types of Heat Treatment	176
9.2.2	Heat Treatment Parameters	181
 Glossary		187
 Bibliography		201
 Index		203