
Contents

Preface	ix
Author Biography	xi
Chapter 1 Introduction	1
Chapter 2 Extremal Materials and Structures	3
2.1 Metamaterials	3
2.2 Extremal Materials	5
2.3 Unusual Properties of Mechanical Metamaterials and Lattices	6
2.4 Adaptive Systems with Extremal Mechanical Properties	8
2.4.1 Programmable Metamaterials	9
2.4.2 Origami-Inspired Metamaterials and Structures	9
2.4.3 Tensegrity-Inspired Metamaterials and Lattices	10
Chapter 3 Tensegrity—Smart Structures with Unusual Mechanical Properties	13
3.1 Smart Structures	13
3.1.1 Definitions	14
3.1.2 Classification	15
3.2 Tensegrity	17
3.3 Inherent Properties of Tensegrity	19
3.3.1 Self-Control	20
3.3.2 Self-Diagnosis	22
3.3.3 Self-Repair	24
3.3.4 Self-Adjustment	26
Chapter 4 Analysis of Tensegrity Systems	29
4.1 Discrete Models	29
4.2 Continuum Models	33
4.3 Scale Effects in the Continuum Model of Tensegrity Lattices	37

Chapter 5	Extremal Mechanical Properties of Tensegrity Systems	41
5.1	Identification of Extremal Mechanical Properties	41
5.2	Tensegrity Modules in 3D Space	43
5.2.1	Three-Strut Simplex Family	45
5.2.2	Four-Strut Simplex Family	50
5.2.3	Expanded Octahedron Family	56
5.2.4	Truncated Tetrahedron Family	61
5.2.5	X-Module Family	66
5.2.6	Parametric Analysis	71
5.3	Tensegrity Lattices in 3D Space	75
5.3.1	Construction of Modular Tensegrity Lattices ..	77
5.3.2	Four-Strut Simplex Lattices	80
5.4	Tensegrity Modules in 2D Space	89
5.4.1	Hexagon 1	90
5.4.2	Hexagon 2	91
5.4.3	Octagon 1	94
5.4.4	Octagon 2	96
5.4.5	Octagon 3	99
5.5	Tensegrity Lattices in 2D Space	101
5.6	From Metamaterial to Structural Scale	102
5.6.1	2D Example	104
5.6.2	3D Example	109
5.7	To Conclude	112
Chapter 6	Technology and Applications	115
6.1	Technological Aspects in Various Scales	115
6.2	Application of Extremal Tensegrity Metamaterials and Structures in Civil Engineering	117
References		119
Index		131