

CONTENTS

Preface		v
Chapter 1	Introduction, Terminology and General Scope	1
	References	5
Chapter 2	Overview of Needs	6
	References	9
Chapter 3	Typical Damage of Bridge Structures	11
	3.1 Classification of Factors Leading to Bridge Deterioration	11
	3.2 Typical Damage of Concrete Structures	21
	3.3 Typical Damage of Bridge Piers and Abutments	23
	3.4 Typical Damage of Concrete Bridge Superstructures	26
	3.5 Typical Damage of Steel and Composite Bridge Superstructures	34
	3.6 Damage to Other Bridge Elements and Structures	42
	References	42
Chapter 4	Assessment and Evaluation Techniques	44
	4.1 Fundamental Methods and Criteria	44
	4.2 Bridge Inspection	51

	4.3	Field Testing and Monitoring	56
	4.4	Laboratory Tests	73
	4.5	Bridge Management System	76
		References	82
Chapter 5		Some General Problems of Bridge Rehabilitation	85
	5.1	General Considerations	85
	5.2	Analytical, Structural and Design Problems	90
	5.3	Economic Problems	98
	5.4	Material Solutions and Repair Techniques	108
	5.5	Maintenance Problems	112
	5.6	Aesthetic Problems	114
		References	115
Chapter 6		Rehabilitation of Concrete Bridge Superstructures	118
	6.1	Classification of Repair Techniques and Materials	118
	6.2	Surface Repair	127
	6.2.1	Introductory remarks	127
	6.2.2	General procedure	128
	6.2.3	Materials	130
	6.2.4	Techniques	137
	6.3	Crack Repair	145
	6.3.1	Introductory remarks	145
	6.3.2	Materials and techniques	146
	6.3.3	Equipment	152
	6.4	Strengthening of Superstructure	155
	6.4.1	Introductory remarks	155
	6.4.2	General classification of methods	157
	6.4.3	Strengthening by enlargement of cross-sections	160
	6.4.4	Strengthening by redistribution of internal forces in transversal direction	164

	6.4.5	Strengthening by installation of additional structural members	166
	6.4.6	Strengthening by lightening of superstructure	168
	6.4.7	Strengthening by prestressing	170
	6.4.8	Strengthening by external plating	180
	6.4.9	Strengthening by CFRP strips	184
	6.4.10	Strengthening by composite fabrics	196
	6.4.11	Strengthening by change of structural system	199
	References		203
Chapter 7		Rehabilitation of Steel and Composite Bridge Superstructures	208
	7.1	Classification of Repair Techniques and Materials	208
	7.2	Corrosion Removal and Surface Cleaning	216
	7.3	Anticorrosion Protection (Coating)	222
		7.3.1 Introductory remarks	222
		7.3.2 Materials and techniques	225
	7.4	Replacement of Structural Members	233
	7.5	Repair of Deformed Structural Members	236
		7.5.1 Allowable deformations	236
		7.5.2 Mechanical repair	241
		7.5.3 Thermal repair (Heating technique)	247
	7.6	Strengthening of Superstructure	254
		7.6.1 Introductory remarks	254
		7.6.2 General classification of methods	255
		7.6.3 Strengthening by enlargement of cross-sections of structural members	259
		7.6.4 Strengthening by installation of additional members	263
		7.6.5 Strengthening by external post-tensioning	266

	7.6.6	Strengthening by change in supporting system	271
	7.6.7	Strengthening by replacement of structural members	274
	7.6.8	Other strengthening methods	276
	7.6.9	Strengthening of structural joints	277
		References	280
Chapter 8		Rehabilitation of Bridge Deck and Bearings	283
	8.1	Typical Damage of Bridge Deck and Bearings	283
	8.2	Rehabilitation of Pavement and Waterproofing Membrane on Bridge Deck	291
	8.3	Rehabilitation of Expansion Joints	296
	8.4	Rehabilitation of Drainage System	309
	8.5	Rehabilitation of Railings, Balustrades and Parapets	314
	8.6	Rehabilitation of Bridge Bearings	317
		References	332
Chapter 9		Rehabilitation of Bridge Substructure	334
	9.1	Introductory Remarks	334
	9.2	Specific Problems of Substructure Rehabilitation	335
	9.3	Rehabilitation of Bridge Abutments	340
	9.3.1	Typical structural and material deteriorations	340
	9.3.2	Repair and rehabilitation of typical deteriorations	341
	9.3.3	Settlement and stability problems	345
	9.3.4	Strengthening of abutment elements	356
	9.4	Rehabilitation of Bridge Piers	358
	9.4.1	Typical structural and material deteriorations	358

9.4.2	Surface repair	359
9.4.3	Strengthening of pier elements	363
9.4.4	Settlement and stability problems	366
9.5	Rehabilitation and Strengthening of Bridge Foundations	372
9.5.1	Repair of material losses	372
9.5.2	Increasing of load-carrying capacity of pier foundations	377
9.5.3	Rehabilitation of scour and landslide effects	383
	References	391
Chapter 10	Modernization of Concrete, Steel and Composite Bridges	392
10.1	Type and Scope of Bridge Modernization	392
10.2	Widening of Bridges	397
10.3	Lifting of Bridge Structures	415
10.4	Upgrading of Bridge Load-Carrying Capacity	425
10.5	Improvement in Bridge Durability	426
10.5.1	Introductory remarks	426
10.5.2	Providing structural continuity	427
10.5.3	Surface protection of bridge structural members	429
10.5.4	Cathodic protection	433
10.5.5	Other measures	438
10.6	Modification of Under Bridge Space and Bridge Surroundings	438
10.7	Improvement in Bridge Aesthetics	443
10.8	Other Modernization Operations	443
	References	444
Index		446