

Contents

<i>Preface to the Second Edition</i>	<i>vii</i>
<i>Preface to the First Edition</i>	<i>xi</i>
1. Introduction	1–15
1.1 Historical Evolution of Bridges	1
1.2 Advantages of Prestressed Concrete Bridges	9
1.3 Pretensioned Prestressed Concrete Bridge Decks	10
1.4 Post-Tensioned Prestressed Concrete Bridge Decks	10
1.5 Modern Trends in Prestressed Concrete Bridges	12
References	15
2. Bridge Loading Standards	16–41
2.1 Evolution of Bridge Loading Standards	16
2.2 Indian Highway Bridge Loading Standards	16
2.3 Highway Bridge Loading Standards of Different Countries	21
2.4 Impact Factors	30
2.5 Comparative Analysis of Highway Bridge Loading Standards	34
2.6 Indian Railway Bridge Loading Standards	37
Review Questions	39
Objective Type Questions	40
References	41
3. Materials for Prestressed Concrete Bridges	42–54
3.1 Introduction	42
3.2 High Strength Concrete Mixes	42
3.3 High Tensile Steel	46
3.4 Untensioned Steel or Supplementary Reinforcement	48
3.5 Permissible Stresses in Concrete	50
3.6 Permissible Stresses in Steel	51
3.7 Anchorages and Sheathing Ducts	51
Review Questions	52
Objective Type Questions	52
References	53
4. Limit State Design of Reinforced and Prestressed Concrete Bridges	55–64
4.1 Basic Concepts of Limit State Design	55
4.2 Limit State Criteria	56
4.3 Partial Safety Factors	57
4.4 Characteristic and Design Loads	57

4.5 Characteristic and Design Strengths	59
4.6 Global Factor of Safety	60
4.7 Design of Prestressed Concrete Sections for Service Loads	60
Review Questions	62
Objective Type Questions	62
References	63
5. Limit State of Strength of Prestressed Concrete Bridge Decks	65–87
5.1 Introduction	65
5.2 Flexural Strength of Prestressed Concrete Sections	65
5.3 Shear Strength of Prestressed Concrete Sections	71
5.4 Torsional Strength of Structural Concrete Sections	76
5.5 Ultimate Strength under Flexure, Shear and Torsion	78
5.6 Forces in End Blocks	83
Assignment	84
Review Questions	86
Objective Type Questions	86
References	87
6. Limit State of Serviceability of Prestressed Concrete Bridge Decks	88–100
6.1 Introduction	88
6.2 Control of Deflections in Bridge Decks	88
6.3 Control of Cracking in Bridge Decks	91
6.4 Minimum Grade of Concrete and Cover Requirements	93
6.5 Analysis Examples	94
Assignment	97
Review Questions	99
Objective Type Questions	99
References	100
7. Prestressed Concrete Slab Bridge Decks	101–129
7.1 General Features	101
7.2 Analysis of Slab Decks	101
7.3 Design Aids and Tables for Prestressed Concrete Bridge Deck Slabs	116
7.4 Maximum and Minimum Reinforcements in Slab	118
7.5 Design of Post-Tensioned Prestressed Concrete Bridge Deck Slab	118
Assignment	126
Review Questions	127
Objective Type Questions	128
References	129
8. Prestressed Concrete Tee Beam and Slab Bridge Decks	130–170
8.1 General Features	130
8.2 Structural Components of Tee Beam and Slab Bridge Decks	130
8.3 Load Distribution Methods for Beam and Slab Bridge Decks	133
8.4 Comparative Analysis of Various Load Distribution Methods	144
8.5 Design of Post-Tensioned Prestressed Concrete Tee Beam and Slab Bridge Deck	151
Assignment	167
Review Questions	168
Objective Type Questions	168
References	169
9. Prestressed Concrete Continuous Span Bridge Decks	171–194
9.1 Advantages of Continuous Span Bridge Decks	171
9.2 Methods of Prestressing Continuous Bridge Decks	172
9.3 Cross-Sections of Prestressed Concrete Continuous Bridge Decks	173

9.4 Design of Post-Tensioned Prestressed Concrete Continuous Two Span Beam and Slab Bridge Deck	173
Assignment	191
Review Questions	192
Objective Type Questions	193
References	194
10. Prestressed Concrete Cellular Box Girder Bridge Decks	195–220
10.1 General Features	195
10.2 Advantages of Segmental Box Girder Construction for Long Span Bridge Decks	195
10.3 Typical Cross-Sections of Cellular Box Girder Decks	196
10.4 Analysis of Box Girder Bridge Decks	197
10.5 Design Principles of Box Girder Bridge Decks	200
10.6 Construction of Box Girder Bridges	203
10.7 Design of Post-Tensioned Prestressed Concrete Two Span Cellular Box Girder Bridge Deck	204
Assignment	216
Review Questions	218
Objective Type Questions	218
References	219
11. Design of Prestressed Concrete Rigid Frame Bridges	221–242
11.1 General Features	221
11.2 Advantages of Rigid Frame Bridges	221
11.3 Design Principles of Prestressed Concrete Portal Frames	223
11.4 Design of Prestressed Concrete Rigid Frame Bridge	226
Assignment	238
Review Questions	240
Objective Type Question	241
References	242
12. Prestressed Concrete Cable Stayed Bridges	243–287
12.1 Evolution of Cable Stayed Bridges	243
12.2 Advantages of Cable Stayed Bridge Decks	243
12.3 Structural Components of Cable Stayed Bridges	245
12.4 Towers or Pylons	246
12.5 Cable Stays	246
12.6 Longitudinal Cable Profiles	251
12.7 Superiority of Cable Stayed Bridges over Conventional Bridges	252
12.8 Basic Principles of Structural Analysis	254
12.9 Structural Analysis of Cable Stayed Bridges	256
12.10 Structural Anchorages	267
12.11 Dynamic Behaviour and Aerodynamic Stability	267
12.12 Construction Methods	270
12.13 Economic Studies	271
12.14 Design of Prestressed Concrete Cable Stayed Bridge Deck	273
Assignment	281
Review Questions	285
Objective Type Questions	285
References	286
13. Planning and Economical Aspects of Prestressed Concrete Bridges	288–300
13.1 Introduction	288
13.2 Structural Forms for Bridges	288
13.3 Cost Considerations of Different Types of Bridge Decks	289
13.4 Economic Evaluation	296

13.5 Prestressed Concrete Flyovers	297
Review Questions	298
Objective Type Questions	299
References	300
14. Construction of Prestressed Concrete Bridges	301–324
14.1 Introduction	301
14.2 High Strength Concrete Mixes	301
14.3 Batching and Mixing of Concrete	303
14.4 Placing of Concrete in Forms	304
14.5 Compaction of Concrete By Vibration	304
14.6 Rheodynamic Concrete	305
14.7 Expansion Joints for Bridge Decks	305
14.8 Assembly of Prestressing Steel and Grouting of Ducts	308
14.9 Long Span Bridge Construction Techniques	308
Review Questions	322
Objective Type Questions	323
References	324
15. Maintenance and Rehabilitation of Prerstressed Concrete Bridges	325–352
15.1 Introduction	325
15.2 General Features of Bridge Maintenance and Rehabilitation	325
15.3 Maintenance Methodology	326
15.4 Inspection of Bridges	327
15.5 Inspection Instrumentation	328
15.6 Cracks in Prestressed Concrete Bridges	329
15.7 Repairs and Rehabilitation of Bridges	336
15.8 Repairs of Girders Damaged by Collision	339
15.9 Restoration of damaged Prestressed Concrete Beams	339
15.10 Strengthening of Beams by Externally Bonded Plates	343
15.11 Case Studies of Repairs and Rehabilitation of Bridges	345
Review Questions	350
Objective Type Questions	350
References	351
16. World's Prominent Prestressed Concrete Bridges	353–369
16.1 General Aspects	353
16.2 World's Long Span Prestressed Concrete Bridges	354
16.3 Notable Examples of Prestressed Concrete Bridges	354
16.4 List of World's Longest Span Prestressed Concrete Bridges	368
References	368
Appendices	371–383
Appendix 1: Properties of Prestressing Steels	371
Appendix 2: Constants for Beam Sections	373
Appendix 3: Post-Tensioning Systems	377
Appendix 4: Bending Moment and Shear Force Coefficient for Continuous Beams	381
Appendix 5: Grouting of Post-Tensioned Ducts	382
Subject Index	385–388
Author Index	389–390