Prestressed Concrete
## Contents

**Foreword**  
**Preface**  
**Acknowledgements**  
**Notations**

### 1. Introduction
1. Development of Prestressed Concrete  
2. Advantages of Prestressed Concrete  
3. Classification of Types of Prestressing  
4. Tendons and Cables  
5. Concepts of Prestressing

### 2. Materials
1. Introduction  
2. Concrete  
3. High Tensile Steel  
4. Corrosion of Prestressing Steel  
5. Modern Materials

### 3. Prestressing Systems and Devices
1. General  
2. Anchorage by Embedment  
3. Anchorage by External Components  
4. Couplers  
5. Non-Conventional Prestressing

### 4. Analysis for Flexure (Prestressed Concrete Elements)
1. General  
2. Behaviour of Prestressed Concrete Elements in Flexure  
3. Basic Assumptions  
4. Notations  
5. General Concept of Stresses  
6. Prestressing Force Transferred by Pretensioning System
### Contents

4.7 Prestressing Force Transferred by  
Post Tensioning System  90  
4.8 Resultant Compression Line (C.G.C. line)  107  
4.9 Load Balancing Concept  115  

References  119

5. Losses in Prestress  120  
5.1 Introduction  120  
5.2 Immediate losses  122  
5.3 Time dependent losses  140  

References  153

6. Ultimate Strength in Flexure  154  
6.1 General  154  
6.2 Failure of Beam by Fracture of Steel  157  
6.3 Failure of Under Reinforced Beams  158  
6.4 Failure of Over Reinforced Beams  159  
6.5 Balanced Beam  160  
6.6 Design Failure Loads and Moments  160  
6.7 Evaluation of Failure Load/Failure Moment  162  
6.8 Code Provisions  173  

References  194

7. Philosophy of Design  196  
7.1 Introduction  196  
7.2 Concepts of Limit States and Partial Safety Factors  197  
7.3 Design Loads and Stresses  197  
7.4 Limit State of Collapse  200  
7.5 Limit State of Serviceability  201  

References  218

8. Design for Flexure  219  
8.1 Introduction  219  
8.2 Flexural Design Using Allowable  
Stresses at Service Load  221  
8.3 Stress Range Approach  223  
8.4 Lins Approach  225  
8.5 Magnel's Approach  239  

References  252

9. Shear and Torsional Behaviour (Analysis and Design)  253  
9.1 Concept of Shear  253  
9.2 Mechanism of Shear Resistance in Concrete Beams  253  
9.3 Design for Shear in Prestressed Concrete Beams  260  
9.4 Shear in Flanged Beams  268  
9.5 Concept of Torsion  277  
9.6 Behaviour of Structural Elements Under Torsion  277  
9.7 Failure of Concrete Elements Under Torsion  278
9.9 British Code Provision BS 8110–1985 295

References 301

10. Transmission and Anchorage Zone (Analysis and Design) 303
10.1 General 303
10.2 Pretensioned Prestressed Concrete Elements 303
10.3 Post Tensioned Prestressed Concrete Elements 308
10.4 Indian Standards Code Provisions 324
10.5 FIP Recommendations—1984 Specifications 325
10.6 BS 8110–1985 Specifications 328
10.7 Detailing of Reinforcement in General 329

References 331

11. Composite Construction 332
11.1 General 332
11.2 Need for Composite Construction 333
11.3 Types of Composite Construction 333
11.4 Behaviour of Composite Construction 335
11.5 Flexural Stresses 338
11.6 Longitudinal Shear Transfer 338
11.7 Transverse Shear 341
11.8 Creep and Shrinkage Effects in Composite Construction 343
11.9 Stage Prestressing 346
11.10 Additional Design Considerations 351

References 354

12. Statically Indeterminate Structures (Analysis and Design) 355
12.1 General 355
12.2 Analysis of Prestressed Indeterminate Structures 356
12.3 Continuous Beams 356
12.4 Linear Transformation and Concordancy of Cable Profiles 370
12.5 Frames 374
12.6 Choice of Prestressing and Cable Profiles 379
12.7 Comparison for Choice for Best Profile 385
12.8 Effect of Time Dependent Deformation on Indeterminate Prestressed Concrete Structures 385

References 387

13. Cylindrical Structures in Prestressed Concrete—Pipes and Tanks (Analysis and Design) 388
13.1 General 388
13.2 Prestressed Concrete Pipes 389
13.3 Types of Prestressed Concrete Pipes 389
13.4 Unique Properties of Non-Cylinder Prestressed Pipes 391
13.5 Advantages of Prestressed Concrete Pipes 392
13.6 Loads on Pipes 393
13.7 Design of Prestressed Concrete Pipes 394
13.8 Design of Prestressed Concrete Non Cylinder Pipes 397
13.9 Prestressed Concrete Water Tanks 403
13.10 Choice of Shape of Tanks 404
13.11 Structural Behaviour of Cylindrical Tanks 404
13.12 Design Effects of Prestressing 408
13.13 Design for Flexure in Vertical Plane 409
13.14 Influence Line for Moments in Vertical Plane 416
13.15 Design Procedure 419
13.16 Design Example 419
13.17 Construction Problems 427
References 428

14.0 General 430
14.1 Case for Partial Prestressing 432
14.2 Partial Prestressing and the Codes of Practice 433
14.3 Definitions for Partial Prestressing 433
14.4 Analysis 434
14.5 Design 443
14.6 Cracks and Crack width 449
References 452

15. Other Structures 454
15.0 General 454
15.1 Flat Slabs 454
15.2 Two Sides Supported Slabs 456
15.3 Skew Slabs 466
15.4 Folded Plates 472
15.5 Cylindrical Shell Structures 475
15.6 Doubly Curved Shell Structures 476
References 477

Subject Index 479