This volume II elucidates the basic principles involved in the analysis and design of Advanced Reinforced Concrete Structures.

The entire subject matter is divided in Twenty Two chapters. These chapters are arranged in four groups.

The first group of chapter one to chapter eight contains the advanced topics in the design of beams, slabs and foundation. The name of the chapters are circular slabs; Ribbed and Waffle slabs; Flat Slab; Domes; Deep Beams and Corbels; beams Curved in Plan; Grid or coffered floors; Circular Raft Foundations.

The second group of chapter nine to chapter sixteen discusses analysis and design of multi-storeyed buildings with an example of an Unbraced building following the latest IS codes on earth quake and ductile detailing. Shear walls are also introduced. It contains chapter viz., multi-storeyed buildings: Fundamentals; Analysis and design for Gravity Loads: an overview; Lateral Loads, Wind loads, Earthquake loads; Analysis of Lateral loads; Ductility considerations; Unbraced building design examples; Walls in buildings.

In the third group of chapter seventeen to chapter twenty one, the topics on water tanks are introduced and designed in accordance with IS: 3370-2009. The Chapters are: Water Tanks: fundamentals; Circular tanks; Rectangular Tanks; Elevated Water tanks; Intze Tanks are given.

The fourth group is chapter twenty two which contains chapter on Element of Prestressed Concrete.

The salient features of the book are:

- Simple, lucid and easy language;
- Professional approach to designs;
- Step-by-step treatment;
- Comprehensive presentation;
- Exposure to practical problems;
- Excellent detailing.

This book now contains:

- 303 Self explanatory and neat diagrams
- 63 Fully solved designs/problem
- 162 Examples and Questions for practice
- 156 Useful tables
- 64 Short questions with answers.

It is hoped that the book should be extremely useful to the Civil Engineering and Architecture students preparing for Degree Examinations of all Indian Universities, Diploma Examinations conducted by various Boards of Technical Education, Certificate Courses, as well as for the A.M.I.E., U.P.S.C., G.A.T.E. and other similar competitive and professional Examinations. It should also prove of great interest and practical use to the practicing engineers.

**CONTENT**

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CIRCULAR SLABS</td>
</tr>
<tr>
<td>2</td>
<td>RIBBED SLABS AND WAFFLE SLABS</td>
</tr>
<tr>
<td>3</td>
<td>FLAT SLABS</td>
</tr>
<tr>
<td>4</td>
<td>DOMES</td>
</tr>
<tr>
<td>5</td>
<td>DEEP BEAMS AND CORBELS</td>
</tr>
<tr>
<td>6</td>
<td>BEAMS CURVED IN PLAN</td>
</tr>
<tr>
<td>7</td>
<td>GRID OR COFFERED FLOORS</td>
</tr>
<tr>
<td>8</td>
<td>CIRCULAR RAFT FOUNDATIONS</td>
</tr>
<tr>
<td>9</td>
<td>MULTI-STOREYED BUILDINGS: FUNDAMENTALS</td>
</tr>
<tr>
<td>10</td>
<td>ANALYSIS AND DESIGN FOR GRAVITY LOADS: AN OVERVIEW</td>
</tr>
<tr>
<td>11</td>
<td>LATERAL LOADS</td>
</tr>
<tr>
<td>12</td>
<td>ANALYSIS FOR LATERAL LOADS</td>
</tr>
<tr>
<td>13</td>
<td>DUCTILITY CONSIDERATIONS</td>
</tr>
<tr>
<td>14</td>
<td>UNBRACED BUILDING DESIGN EXAMPLE - I</td>
</tr>
<tr>
<td>15</td>
<td>UNBRACED BUILDING DESIGN EXAMPLE - II</td>
</tr>
<tr>
<td>16</td>
<td>WALLS IN BUILDINGS</td>
</tr>
<tr>
<td>17</td>
<td>WATER TANKS: FUNDAMENTALS</td>
</tr>
<tr>
<td>18</td>
<td>CIRCULAR TANKS</td>
</tr>
<tr>
<td>19</td>
<td>RECTANGULAR TANKS</td>
</tr>
<tr>
<td>20</td>
<td>ELEVATED WATER TANKS</td>
</tr>
<tr>
<td>21</td>
<td>INTZE TANK</td>
</tr>
<tr>
<td>22</td>
<td>ELEMENTS OF PRESTRESSED CONCRETE</td>
</tr>
<tr>
<td>Appendix A :</td>
<td>SHORT QUESTIONS WITH ANSWERS</td>
</tr>
<tr>
<td>Appendix B :</td>
<td>USEFUL TABLES</td>
</tr>
<tr>
<td>INDEX</td>
<td></td>
</tr>
</tbody>
</table>
## REINFORCED CONCRETE – VOL. II

### DETAILED CONTENTS

**Chapter 1 CIRCULAR SLABS**
- 1-1. Introductory
- 1-2. Analysis
  - EXAMPLES I

**Chapter 2 RIBBED SLABS AND WAFFLE SLABS**
- RIBBED SLABS
  - 2-1. Introductory
  - 2-2. Proportioning the dimensions
  - 2-3. Analysis and design procedure
  - WAFFLE SLABS
  - 2-4. Two-way spanning ribbed slabs: Waffle slabs
  - EXAMPLES II

**Chapter 3 FLAT SLABS**
- 3-1. Introductory
- 3-2. Column and middle strips
- 3-3. Proportioning of flat slab elements
- 3-4. Design methods for flat slabs
  - DIRECT DESIGN METHOD (D.D.M.)
  - 3-5. Total design moment
  - 3-6. Distribution of moments in slabs
  - 3-7. Effect of pattern loading
  - 3-8. Transfer of floor loads into columns
  - 3-9. Design for shear
  - 3-10. Provision of reinforcement
  - 3-11. Moments in columns
  - EXAMPLES III

**Chapter 4 DOMES**
- 4-1. Introductory
- 4-2. Stresses in domes
- 4-3. Formulae for forces in spherical domes
- 4-4. Design of a spherical dome
- 4-5. Working stress method of design
- 4-6. Formulae for forces in conical domes
  - EXAMPLES IV

**Chapter 5 DEEP BEAMS AND CORBELS**
- 5-1. Introduction
  - DEEP BEAMS
  - 5-2. Definitions
  - 5-3. Design and details of reinforcements
  - CORBELS
  - 5-4. Corbels
  - 5-5. Shear friction
  - 5-6. Corbel dimensions
  - 5-7. Design of a corbel
  - EXAMPLES V

**Chapter 6 BEAMS CURVED IN PLAN**
- 6-1. Introductory
- 6-2. Circular beam
- 6-3. Circular arc fixed at ends
- 6-4. Design of beams curved in plan
  - EXAMPLES VI

**Chapter 7 GRID OR COFFERED FLOORS**
- 7-1. Introduction
- 7-2. Analysis of grid floors
- 7-3. Plate theory
  - EXAMPLES VII

**Chapter 8 CIRCULAR RAFT FOUNDATIONS**
- 8-1. Introduction
  - ANNULAR RAFT
  - 8-2. Soil design of an annular raft
  - 8-3. Formulae for annular raft
  - 8-4. Design for flexure and shear
    - SOLID RAFT
  - 8-5. Solid raft
    - EXAMPLES VIII

**Chapter 9 MULTI-STORYED BUILDINGS: FUNDAMENTALS**
- 9-1. Contributing factors to multi-storeyed buildings
- 9-2. Nomenclatures
- 9-3. Loads on multi-storeyed buildings
- 9-4. Load combinations
- 9-5. Role of the floor diaphragm
- 9-6. Shear walls
- 9-7. Unbraced, braced and dual structures
- 9-8. Structural systems
- 9-9. Low rise, medium rise and tall buildings
- 9-10. Structural layout
- 9-11. Analysis, design and detailing (ADD)
- 9-12. Distinguishing factors to design of tall buildings
  - EXAMPLE IX

**Chapter 10 ANALYSIS AND DESIGN FOR GRAVITY LOADS: AN OVERVIEW**
- 10-1. Introduction
- 10-2. Calculation of gravity loads
- 10-3. Area method
- 10-4. Beam reaction method
- 10-5. Live load reduction
- 10-6. Column load calculations
- 10-7. Gravity load analysis
- 10-8. Important analysis parameters
- 10-9. Design of floor
- 10-10. Analysis and design of columns
- 10-11. Tie beams and ground beams
- 10-12. Footings
- 10-13. Computer methods
- 10-14. Conclusion
  - EXAMPLE X

**Chapter 11 LATERAL LOADS**
- 11-1. Introductory
- 11-2. Centre of mass and centre of rigidity
  - WIND LOADS
- 11-3. Wind loads
- 11-4. Wind pressure on buildings
- 11-5. Wind loads on buildings
  - EARTHQUAKE LOADS
- 11-6. The earthquake
- 11-7. Interior of the earth
- 11-8. Tectonic plates
- 11-9. Causes and occurrence of an earthquake
- 11-10. Terminology
- 11-11. Measurement of ground motion
- 11-12. Magnitude of earthquake
- 11-13. Intensity of earthquake (Damage Potential)
- 11-14. Ground accelerations
- 11-15. Behaviour of buildings during earthquakes
- 11-16. Important parameters
- 11-17. General seismic analysis and design principles
- 11-18. Seismic weight
- 11-19. Methods of analysis for earthquake forces
- 11-20. Fundamental natural period
- 11-21. Design spectrum
- 11-22. Response reduction factor (R)
- 11-23. Soil types
  - EXAMPLES XI
Chapter 12 ANALYSIS FOR LATERAL LOADS
12-1. Introduction
12-2. Accidental eccentricity
12-3. Design eccentricity
12-4. Distribution of lateral forces to vertical lateral load resisting elements
12-5. First order lateral displacements: Storey drift
12-6. Displacements due to rotation of columns and girders
12-7. Lateral stiffness of the storey
12-8. Displacement due to cantilever action of the space frame
12-9. P-Delta effect: Stability index
12-10. Analysis of building for lateral loads
12-11. Analysis of a frame subjected to wind or earthquake loads
12-12. The portal method
12-13. The cantilever method
12-14. Closure

Chapter 13 DUCTILITY CONSIDERATIONS
13-1. Introductory
13-2. Capacity design concept
13-3. Strong beam-weak column verses strong column weak beam design
13-4. Material requirements
13-5. Flexural members
13-6. Columns and frame members subjected to bending and axial loads
13-7. Design of transverse reinforcements for ductile column

Chapter 14 UNBRACED BUILDING DESIGN EXAMPLE - I
14-1. Requirements of the example
14-2. Global and local axes

Chapter 15 UNBRACED BUILDING DESIGN EXAMPLE - II
15-1. Design of the building
15-2. Design of typical floor
15-3. Design data for columns
15-4. Design of columns
15-5. Design of ground beams
15-6. Design of footings
15-7. Closure

Chapter 16 WALLS IN BUILDINGS
16-1. Introductory
16-2. Classification of walls
16-3. Effective height of walls
16-4. Minimum thickness of the wall

Appendix A SHORT QUESTIONS WITH ANSWERS
Appendix B USEFUL TABLES
Index