

UNIT I

Chapter 1 : Basics of Maintenance and Repairs	1-1 to 1-18
1.1 Introduction	1-1
1.2 Maintenance	1-2
1.2.1 Classification of Maintenance	1-2
1.3 Common Terms	1-6
1.3.1 Repair	1-6
1.3.2 Retrofitting	1-6
1.3.3 Re-strengthening	1-7
1.3.4 Rehabilitation	1-8
1.3.5 Restoration	1-8
1.4 Necessity of Maintenance and Repairs	1-8
1.5 Objectives of Maintenance	1-9
1.6 Importance of Maintenance and Repair	1-9
1.7 Factors Influencing the Maintenance and Repairs	1-10
1.8 Advantages and Disadvantages of Maintenance and Repairs	1-11
1.8.1 Advantages	1-11
1.8.2 Disadvantages	1-12
1.9 Approach of Effective Management for Maintenance and Repairs	1-12
1.10 Periodical Maintenance	1-13
1.10.1 Maintenance Manual	1-14
1.11 Pre and Post Monsoon Maintenance	1-15
1.11.1 Pre-monsoon Maintenance	1-16
1.11.2 Post-monsoon Maintenance	1-17

UNIT II

Chapter 2 : Causes and Detection of Damages	2-1 to 2-34
2.1 Introduction	2-1
2.2 Causes of Damages	2-2
2.2.1 Distress	2-2
2.2.2 Earthquake	2-3
2.2.3 Wind	2-3



2.2.4	Flood	2-4
2.2.5	Dampness.....	2-4
2.2.6	Corrosion.....	2-5
2.2.7	Fire	2-6
2.2.8	Dilapidation.....	2-6
2.2.9	Termite	2-7
2.3	Systematic Approach of Damage Detection.....	2-7
2.3.1	Preliminary Investigation.....	2-8
2.3.2	Physical Inspection.....	2-8
2.3.3	Material Testing.....	2-9
2.3.4	Non-destructive Test.....	2-9
2.3.5	Detailed Investigation.....	2-10
2.3.6	Study of Available Documents.....	2-10
2.3.7	Estimation of Actual Loads and Environmental Effects.....	2-11
2.3.8	Errors in Design and Construction.....	2-11
2.3.9	Retrospective Analysis.....	2-11
2.3.10	Strengthening Requirements.....	2-12
2.3.11	Relevant Approaches to Repair.....	2-12
2.4	Various Aspects of Visual Observations for Detection of Damages.....	2-13
2.5	Tests on Damaged Structure.....	2-14
2.5.1	Non-destructive Test.....	2-15
2.5.2	Various Non-destructive Testing Methods.....	2-16

UNIT III

Chapter 3 : Materials for Maintenance and Repairs	3-1 to 3-22	
3.1	Factors Influencing the Material Selection.....	3-2
3.2	Anti Corrosion Coating Materials.....	3-4
3.2.1	Cement Slurry Mortar.....	3-5
3.2.2	Polymer Modified Cement Slurry.....	3-5
3.2.3	Epoxy Zinc.....	3-5
3.3	Adhesive Materials.....	3-5
3.3.1	Solvent Free Adhesive.....	3-6
3.3.2	Epoxy Adhesive.....	3-6



3.3.3	Polyester Adhesive.....	3-7
3.3.4	Acrylic Adhesive.....	3-7
3.3.5	Water Borne Adhesive	3-8
3.3.6	Polyvinyl Acetate	3-8
3.3.7	Vinyl Acetate Co-polymer	3-8
3.4	Mortar Repair Materials	3-8
3.4.1	Cementitious Mortar	3-9
3.4.2	Polymer Modified Cementitious Mortar	3-9
3.4.3	Resin Mortar	3-10
3.5	Joint Sealant Materials.....	3-10
3.5.1	Oleo Resinous Mastic	3-11
3.5.2	Bitumen or Rubber based Sealant	3-11
3.5.3	Acrylic Resin Sealant.....	3-11
3.6	Grout Materials	3-12
3.6.1	Cement Grout.....	3-12
3.6.2	Cement Sand Grout	3-12
3.6.3	Cement Sand Grout with Additives	3-12
3.6.4	Polymer Modified Cement Grout.....	3-13
3.6.5	Epoxy Grout.....	3-13
3.7	Waterproofing Roof Materials.....	3-13
3.7.1	Polyisobutylene (PIP/PIB) Sheet	3-14
3.7.2	Glass Fiber Reinforced Plastic	3-14
3.7.3	Bitumen and Bituminous Emulsion	3-14
3.7.4	Latex Cement Coating.....	3-15
3.8	Surface Coating Materials for Concrete Protection	3-16
3.8.1	Bituminous Cutbacks	3-17
3.8.2	Chlorinated Rubber Coating.....	3-17
3.8.3	Vinyl Coatings.....	3-17
3.8.4	Epoxy Coating.....	3-18
3.8.5	Coal Tar Epoxy	3-18
3.9	Additional Repairing Materials.....	3-18
3.9.1	Plastic or Aluminium Nipples	3-19
3.9.2	Polyester Putty.....	3-19

3.9.3	1:3 Cement Sand Mortar.....	3-19
3.9.4	Galvanized Steel Wire Fabrics	3-20
3.9.5	Clamping Rods	3-21

UNIT IV

Chapter 4 : I Maintenance and Repair Methods for Masonry 4-1 to 4-31

4.1	Causes of Wall Cracks.....	4-1
4.1.1	Cracks in Wall Due to Bulging of Wall.....	4-2
4.1.2	Cracks in Wall Due to Shrinkage.....	4-2
4.1.3	Cracks in Wall Due to Thermal Movement	4-3
4.1.4	Cracks Due to Foundation Movement and Settlement of Soil (Shear Cracks).....	4-5
4.1.5	Cracks Due to Growth of Vegetation.....	4-5
4.2	Probable Crack Location Such as Junction of Main and Cross Wall, Junction of RCC Column and Wall, Junction of Slab and Wall, Cracks in Masonry Joints.....	4-7
4.2.1	Cracks in External and Internal Walls of Load-Bearing and Non-Load Bearing Structures.....	4-7
4.2.1.1	Crack in Non-Load Bearing Wall-Cladding and Cross-Walls of Framed Structure.....	4-7
4.2.1.2	Crack in Partition Walls in Load-Bearing Structures.....	4-7
4.2.2	Vertical Cracks at Junction of R.C.C. Column and Wall Masonry.....	4-8
4.2.3	Horizontal Crack at the Junction of Roof Slab and Masonry Wall Support.....	4-8
4.2.4	Cracks in Masonry Joints.....	4-9
4.3	Stages of Repairs	4-9
4.3.1	Surface Preparation.....	4-10
4.3.2	Fixing of Suitable Formwork.....	4-10
4.3.3	Bonding / Passivating Coat	4-10
4.3.4	Repair Application.....	4-10
4.4	Repair Techniques: Patch Spalling Replacement or Delaminating and Epoxy Bonded Mortar	4-12
4.4.1	Patch Spalling Replacement.....	4-12
4.4.2	Epoxy Bonded Mortar.....	4-12
4.5	Repairing Methods for Minor and Medium Cracks Include Epoxy Injection, Grooving and Sealing, Shotcrete, Stitching, Grouting and Guniting	4-13
4.5.1	Epoxy Injection	4-14
4.5.2	Grooving and Sealing	4-14
4.5.3	Shotcreting / Guniting Method.....	4-15

4.5.4	Stitching Method	4-15
4.5.5	Grouting	4-16
4.6	Repairing Methods for Major Cracks and Damaged Concrete	4-16
4.7	Dampness in Walls: Causes, Effects, Remedies	4-18
4.7.1	Causes	4-18
4.7.2	Effects	4-19
4.7.3	Remedies	4-19
4.7.3.1	Temporary Remedies for Internal Walls	4-20
4.7.3.2	Temporary Remedies for External Walls	4-20
4.7.3.3	Permanent Remedies	4-20
4.7.3.4	Damp proof course and its repairs	4-21
4.8	Foundation Settlement : Causes, Remedies, Improvement Techniques	4-25
4.8.1	Causes of Foundation Settlement	4-25
4.8.2	Made-up Soil and Improvement Techniques	4-26
4.8.2.1	Improvement of Soft Soil by Compaction	4-26
4.8.2.2	Improvement of Soft Soil by Stone Columns	4-27
4.8.2.3	Improvement of Soft Soil by Grouting	4-27
4.8.2.4	Improvement of Soft Soil by Sand Piles	4-29
4.8.2.5	Improvement of Soft Soil by Increasing Depth of Foundation	4-30

UNIT V

Chapter 5 : Maintenance and Repair Methods for RCC 5-1 to 5-23

5.1	Probable Location of Cracks in RCC Elements, Various Causes of RCC Failure	5-2
5.2	Causes of Dampness in Roof Slab and its Repair Techniques Such as Mud Phuska with Brick Tile Topping, Lime Concrete Terracing, Ferro-Cement Topping and Brickbat Coba	5-4
5.2.1	Mudphuska with Brick Tile Treatment	5-5
5.2.2	Lime Dhar Terrace or Lime Concrete Terracing	5-6
5.2.3	Ferrocement for Water Proofing	5-6
5.2.4	Brick-bat Coba	5-7
5.3	Repair Methods for Cracks in RCC Structures Such as Epoxy Injection, Grooving and Sealing, Stitching, Rebaring, Grouting, Spalling and Replacement, Jacketing, Shotcrete and Gunitting	5-8
5.3.1	Epoxy Injection	5-8



5.3.2	Grooving and Sealing	5-9
5.3.3	Stitching	5-9
5.3.4	Rebaring.....	5-12
5.3.5	Grouting	5-13
5.3.6	Spalling and Replacement	5-14
5.3.7	Jacketing.....	5-15
5.3.8	Shotcrete and Gunitting.....	5-17
5.4	Repair of Corroded RCC Element : Exposing and Undercutting Rebar, Cleaning Reinforcing Steel, Compensating Reinforcement and Protective Coating	5-18
5.4.1	Exposing and Undercutting Rebar.....	5-19
5.4.2	Cleaning Reinforcing Steel.....	5-19
5.4.3	Compensating Reinforcement	5-19
5.4.4	Surface Conditioning of Concrete.....	5-20
5.5	Repair Methods for Honeycomb and Larger Voids.....	5-20
5.5.1	Poured concrete	5-21
5.5.2	Replaced concrete	5-21
5.5.3	Sealing of cracks	5-21
5.5.3	Sealing of cracks	5-22

UNIT VI

Chapter 6 : Structural Audit and Budget	6-1 to 6-33
6.1 Necessity and Importance of Structural Audit and Budget Estimation.....	6-1
6.1.1 Necessity and Importance of Structural Audit.....	6-1
6.1.2 Necessity and Importance of Budget Estimation.....	6-2
6.2 Distress Survey, Detailed Inspection and Recommendations for Budget Estimation	6-3
6.2.1 Distress Survey	6-3
6.2.2 Detailed inspection	6-3
6.2.3 Recommendations for Budget Estimation	6-4
6.3 Steps involved in Structural Audit and Budget Estimation	6-5
6.3.1 Steps involved in Structural Audit.....	6-5
6.3.2 Steps involved in Budget Estimation.....	6-9
6.4 Formats Preparation for Structural Audit	6-10
6.5 Overview on Rules and Regulation of Structural Audit and Budget Estimation.....	6-20

