Savitribai Phule Pune University

B.E. Civil (2015 Course)
401 010 Elective IV: Open Elective: 5(f)

REPAIRS AND REHABILITATION OF CONCRETE STRUCTURES

Teaching Scheme
Lecture: 3 hours / week
Practicals: 2 hours / week

Examination Scheme
Theory Examination:
In-Sem: 30 Marks (1 hour)
End-Sem: 70 Marks (2 ½ hours)
Term work: 50 marks

Objectives:

This subject aims to impart knowledge and understanding that would enable the students to

1. To assess causes and extent of deterioration of concrete structures
2. To understand the durability considerations right from design to execution of construction
3. To understand the protection measures to be taken against moisture percolation and environmental distress
4. To evaluate and select the right repair materials and methodology to increase the life structures

Detailed Syllabus:

Unit 1: Causes of Deterioration of Concrete Structures (06 hours) Damage to Concrete: mechanical actions, chemical attacks, physical actions, fire. Damage to reinforcement: corrosion induced by carbonation of concrete, chloride induced corrosion, corrosion induced by leaching of concrete, corrosion mechanisms of pre-stressed steel. National and International codal provisions for durability considerations, making of durable concrete, selection of materials and quality considerations, good construction management for long-term sustainability.

Unit 2: Assessment of Damage (06 hours) Preliminary assessment – documentation of the general condition of the structure. Detailed surface inspection: mapping of chloride induced corrosion and carbonation induced corrosion, potential mapping and resistivity mapping, cracks and crack mapping. Determination of concrete properties by non-destructive techniques, corrosion activity, loss of cross section, chloride concentration, carbonation depth, concrete cover, concrete endoscopy and thermal imaging, pull-off and pull-out test.

Unit 3 Protection of Concrete Structures (06 hours)
Protective materials and their properties, Moisture barrier systems for super-structures, below grade waterproofing of concrete structures, waterproofing systems like integral, crystalline, coatings, membranes etc. Thermal and chemical resistant protective coatings, solar reflective coatings, insulation systems, glazing etc.

Unit 4: Materials and Methodology of Repairs (06 hours)
Repair analysis and design, repair materials and their properties, methodologies of crack and patch repair, Polymer modified mortar, polymer modified concrete, polymer concrete, injection grouting, shortcreting,

joints and sealants, rebar corrosion crack repair. seismic strengthening of existing R C structures, repair and restoration of heritage structures.

Unit 5: Corrosion protection for reinforcement (06 hours)

Mechanism of corrosion, preventive measures, types of corrosion resistant reinforcement, repair methods, materials. Repair of damaged water retaining structures, hydraulic structures, underwater repair.

Unit 6: Strengthening of damaged structures (06 hours)

Facets of maintenance, Retrofitting: significance, procedure and its methods. Fibre reinforced polymer: development, axial and tensile behavior, retrofitting of structural component using FRP, FRP strengthening system, retrofitting of Reinforced Concrete member (slab, beam, column and footing) using FRP. Statutory legislation and obligation.

TERMWORK

List of experiments to be performed (Any ten experiments from the following)

1. Report on different repair materials available in the market
2. Conditional analysis survey of any damaged structures by visual observation, crack measurement and preparing a report
3. Practical demonstrations of moisture barrier coatings and membranes.
4. Application of solar reflecting systems and insulating materials
5. Non-destructive tests of concrete
6. Rapid chloride penetration test of concrete
7. Carbonation test of concrete
8. Corrosion analysis by half-cell potential meter
9. Application of waterproofing systems
10. Tests on polymer modified mortar and concrete
11. Adhesion tests on rebars using pull-out test
12. Outdoor exposure tests for measuring weathering of coating

References

1. Concrete Repair and Maintenance, P. H. Emmons and G M Sabnis, Galgotia Publication.
2. Repairs and Rehabilitation – Compilation from Indian Concrete Journals
3. Management of Deteriorating Concrete Structures, George Somerville, Taylor and Francis, Publication.
4. Concrete Building Pathology, Susan Macdonald, Blackwell Publishing
5. Durability of Cement and Cement Composites, C. L. Page, M M Page, Wood Head, Publishing.
6. ACI 440.2R-08, Guide for the design and construction of externally bonded FRP systems for strengthening concrete structures, American Concrete Institute.
7. CPWD hand book on Repairs and Rehabilitation of RCC buildings published by DG (Works), CPWD, Government of India (Nirman Bhawan), http://www.cpwd.gov.in/handbook.pdf
8. Guide to Concrete Repair, Glenn Smoak, US Department of the Interior Bureau of Reclamation, Technical Service Center, http://books.google.co.in
9. Waterproofing Technology – Theory and Practice by M. K. Lakhani.