

<b>INSTITUTE</b>	<b>FACULTY OF TECHNOLOGY</b>
<b>PROGRAM</b>	<b>BACHELOR OF TECHNOLOGY (CIVIL ENGINEERING)</b>
<b>SEMESTER</b>	<b>5</b>
<b>COURSE TITLE</b>	<b>REPAIR AND MAINTENANCE OF STRUCTURE</b>
<b>COURSE CODE</b>	<b>01CI0511</b>
<b>COURSE CREDITS</b>	<b>3</b>

**Objective:**

- 1 To give insight into the subject of concrete repair, its protection and strengthening.
- 2 Study of the Concrete structures are subjected to constant deterioration due to effects of ageing, inadequate maintenance, severe environmental exposure, penetration of catalytic agencies such as moisture, gases like CO<sub>2</sub> & oxygen, chloride ions, industrial pollutants, overused and misused concrete structure.
- 3 To learn about the different types of maintenance strategies for structures.
- 4 To give insight into the subject of concrete repair, its protection and strengthening
- 5 Study of the Concrete structures are subjected to constant deterioration due to effects of ageing, inadequate maintenance, severe environmental exposure, penetration of catalytic agencies such as moisture, gases like CO<sub>2</sub> & oxygen, chloride ions, industrial pollutants, overused and misused concrete structure
- 6 To generate awareness about various types of repair materials and techniques used in structural repair.
- 7 To learn about the different types of maintenance strategies for structures

**Course Outcomes:** After completion of this course, student will be able to:

- 1 Identify the causes and mechanisms of deterioration in concrete structures.
- 2 Assess the condition of structures using various evaluation techniques and non- destructive testing methods.
- 3 Apply appropriate repair materials and methodologies for different types of structural defects.
- 4 Implement repair and retrofitting techniques to enhance the structural integrity and extend the service life of structures.

**Pre-requisite of course:..**

**Teaching and Examination Scheme**

<b>Theory Hours</b>	<b>Tutorial Hours</b>	<b>Practical Hours</b>	<b>ESE</b>	<b>IA</b>	<b>CSE</b>	<b>Viva</b>	<b>Term Work</b>
3	0	0	50	30	20	25	25

<b>Contents : Unit</b>	<b>Topics</b>	<b>Contact Hours</b>
1	<b>Introduction to Structural Repair and Maintenance</b> Introduction to repair and maintenance, retrofitting, rehabilitation. Causes of structural deterioration, Maintenance and its classifications, Necessity, , objectives and importance of maintenance and repair, Types of maintenance, Factors influencing, advantages and limitations of maintenance and repairs.	4
2	<b>Deterioration of Concrete Structure</b> Types of deterioration – Signs, causes & symptoms, Mechanism of deterioration, contributing factors like permeability, inadequate durability & micro-structure of concrete., Physical deterioration due to moisture, temperature, shrinkage, freeze-thaw, abrasion, erosion, cavitation, crystallization of salts, Efflorescence, exposure to severe environment like marine exposure, Chemical deterioration due to corrosion of reinforcement (chloride induced, carbonation induced), Corrosion mechanism, alkali-silica reaction, sulphate attack, Acid attack. Cracks: Cracks in concrete, type, pattern, quantification, measurement & preventive measures.	8
3	<b>Condition Assessment &amp; Evaluation of structures</b> Necessity and importance of structural audit and assessment, Distress survey and detailed inspection of structures, Steps involved in structure assessment and audit, Format preparation for structural audit including general information of structures, structure data. Overview of rules and regulations of structure assessment by public work department., Nondestructive test methods for concrete including Rebound hammer, Ultrasonic pulse velocity, Rebar locator, Corrosion meter, Penetration resistance and pull-out test, Core cutting- Corrosion: Methods for corrosion measurement and assessment including half-cell potential and resistivity, Mapping of data.	8
4	<b>Repair Materials</b> Repair materials:- Various repair materials, Criteria for material selection, Methodology of selection, Health and safety precautions for handling and applications of repair materials Special mortars and concretes Polymer Concrete and Mortar, Quick setting compounds Grouting materials Gas forming grouts, Salfoalumate grouts, Polymer grouts, Bonding agents Latex emulsions, Epoxy bonding agents. Protective coatings Protective coatings for Concrete and Steel Fiber Reinforced Polymers: Types, properties and application Other Repair materials for concrete, steel and masonry	10

<b>Contents : Unit</b>	<b>Topics</b>	<b>Contact Hours</b>
5	<b>Maintenance, Repair and Retrofitting Techniques</b> Critical locations of cracks in RCC elements, various causes of failure, Causes of dampness in roof slab and its repair techniques, Various types of repair methods like epoxy injection, grooving & sealing, stitching, grouting, shotcrete, and gunniting, etc. Repairs methods for honeycombing and larger voids. Repair and retrofitting of corroded RCC elements, Corrosion mitigation techniques to protect the structure from corrosion., Introduction to retrofitting and strengthening, Need and importance of retrofitting and strengthening, Design philosophy of strengthening structures, Techniques available for retrofitting & strengthening including conventional and innovative techniques. Strengthening of existing structures; repairs to overcome low member strength, deflection, cracking, Jacketing: Jacketing, Column jacketing, Beam jacketing, Beam Column joint jacketing, reinforced concrete jacketing, Steel jacketing, FRP jacketing. Strengthening: Strengthening, Beam shear strengthening, Flexural strengthening	12
<b>Total Hours</b>		<b>42</b>

**Textbook :**

- 1 Repair and Strengthening of Concrete structures,, FIP guide,, Thomas Telford, 2004

**References:**

- 1 Testing of Concrete in Structures, 4th Edition, Testing of Concrete in Structures, 4th Edition, J.H.Bungey, S.G.Millard & M.G.Grantham, Taylor & Francis, London & New York, 2006

**Suggested Theory Distribution:**

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery					
<b>Remember / Knowledge</b>	<b>Understand</b>	<b>Apply</b>	<b>Analyze</b>	<b>Evaluate</b>	<b>Higher order Thinking / Creative</b>
15.00	25.00	20.00	20.00	10.00	10.00

**Instructional Method:**

- 1 Prerequisite of the course and its pattern shall be discussed on the commencement of the course.
- 2 Lectures shall be conducted in class room using various teaching aids.
- 3 Presence in all academic sessions is mandatory which shall carry 5% marks of the total internal evaluation

**Instructional Method:**

- 4 At the end of each unit/topic an assignment based on the course content shall be given to the students which shall carry 5% weightage for timely completion and submission of the assigned work.

**Supplementary Resources:**

- 1 [https://onlinecourses.nptel.ac.in/noc23\\_ce06/preview](https://onlinecourses.nptel.ac.in/noc23_ce06/preview)