

Branch Name:	CIVIL ENGINEERING
Program Code:	ET106
Course Title:	Repair and Rehabilitation of Structure
Course Code:	2ET1060604T
Pre-requisite Course:	Basic Knowledge of Building Damage, Repairing Work, N.D. Test.

Course Objectives:

- CO-1: To learn various distress and damages to concrete and masonry structures
- CO-2: To understand the importance of maintenance of structures
- CO-3: To study the various types and properties of repair materials
- CO-4: To assess the damage to structures using various tests
- CO-5: To learn the importance and methods of substrate preparation
- CO-6: To learn various repair techniques of damaged structures, corroded structures.

Teaching and Examination Scheme:

Credit	Teaching Scheme Hours per week				Evaluation Scheme (Marks)								
					Theory (Marks)				Practical (Marks)				Total (Marks)
	L	T	P	Total	SEE		CCA		SEE		CCA		
					Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	
4	3	1	-	4	24	60	16	40	-	-	-	-	100

Course Contents:

Unit No	Topic	Total Hours	Weight age (%)
01	Introduction Overview of distress, deterioration in concrete structures, Scenario of distressed structures world over, Need for repairs and upgrading of structures, General introduction to process (Road-map) to a durable concrete repair.	04	05

	Deterioration Of Concrete Structures 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), Alkali-silica reaction, sulphate attack, Acid attack. Deterioration due to water leakage, fire – detection & mitigation of the same. Deterioration due to ageing, inadequate maintenance, Design & construction deficiencies, overloading etc. Visual deterioration of structures Types of cracks, causes & characteristics of cracking in various structural components like beam, column, slab, masonry walls. Measurement of cracks, interpretation of the cause of particular type of crack	10	25
03	Conditional/Damage Assessment & Evaluation Of Structures Structural assessment Conditional evaluation / Structural Appraisal of the structure – Importance, objective & stages, Conditional/damage assessment procedure, Preliminary & Detailed investigation – Scope, Objectives, Methodology & Rapid visual inspection of structures Damage Assessment allied Tests (Destructive, Semi-destructive, Non destructive) Field & laboratory testing procedures for evaluating the structure for strength, corrosion activity, performance & integrity, durability. Interpretation of the findings of the tests.	11	25
04	Repairs, Rehabilitation & Rehabilitation & Retrofitting Of Concrete Structures Repair materials Criteria for durable concrete repair, Methodology, performance requirements, repair options, selection of repair materials, Preparatory stage of repairs, Different types of repair materials & their application, types of repair techniques. Retrofitting/Strengthening Need for retrofitting, Design philosophy of strengthening structures, Techniques available for strengthening including conventional and advanced techniques. Seismic retrofit of concrete structures Deficiencies in structure requiring seismic retrofit, Design philosophy, Techniques to enhance the seismic resistance of structures, advanced techniques for making seismic resistant structures.	10	25

05	Allied Topics Protection & maintenance of structures - Importance of protection & maintenance, Categories of maintenance, Building maintenance, Corrosion mitigation techniques to protect the structure from corrosion. Long term health monitoring / Structural health monitoring (SHM) Definition and motivation for SHM, Basic components of SHM and its working mechanism, SHM as a tool for proactive maintenance of structures.	06	20
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List of Text and Reference Books:

1. Handbook on Repairs and Rehabilitation of structures, CPWD, Delhi. 2002.
2. M.S.Shetty, Concrete Technology – Theory and Practice, S.Chand and Company, New Delhi, 1992.
3. Santhakumar, A.R., Training Course notes on Damage Assessment and repairs in Low Cost Housing, “RHDC – NBO” Anna University, July 1992.
4. Raikar, R., Learning from failures – Deficiencies in Design, Construction and Service – R & D centre (SDCPL), Raikar Bhavan, Bombay, 1987.
5. Lakshmipathy, M. et al. Lecture notes of Workshop on “Repairs and Rehabilitation of Structures”, 29 -30th October 1999.

E-Resources:

1. <http://nptel.ac.in/>

Course Learning Outcomes (CLO):

1. Identify and define all the terms and concepts associated with deterioration of concrete structures
2. Carry out the damage assessment and Rapid Visual inspection of a building showing signs of deterioration and thus should be able to detect the possible cause /source of deterioration.
3. Develop a knowhow of the Concrete repair industry equipped with variety of repair materials and techniques.
4. Describe and apply the importance of quality control in concrete construction and significance of protection and maintenance of structures.

Course Learning Outcomes (CLO): On completion of this course, the students will be able to:

CLO	Description	Bloom's Taxonomy Level
CLO1	Identify and define all the terms and concepts associated with deterioration of concrete structures	L-1, L-2
CLO2	Carry out the damage assessment and Rapid Visual inspection of a building showing signs of deterioration and thus should be able to detect the possible cause /source of deterioration	L-2, L-3
CLO3	Develop a knowhow of the Concrete repair industry equipped with variety of repair materials and techniques.	L-2, L-3, L-4
CLO4	Describe and apply the importance of quality control in concrete construction and significance of protection and maintenance of structures	L-3, L-4

L1- Remember, **L2-** Understand, **L3-** Apply, **L4-** Analyze, **L5-** Evaluate, **L6-** Create

Mapping of CLOs with POs & PSOs

	Program Outcomes (POs)												Program Specific Outcomes (PSOs)		
Course Learning Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
CLO1	M	M		M				M			L	M	M		M
CLO2	M	M	M				M					M	M	M	M
CLO3	M	M	M	M	H			L				M	M	M	M
CLO4	M			M		M	L	H			M	M	M		

H: High, **M:** Medium, **L:** Low