



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad - 500 043

CIVIL ENGINEERING

COURSE INFORMATION SHEET

Course Title	Rehabilitation & Retrofitting of structure			
Course Code	BST214			
Programme	M. Tech			
Semester	M. Tech - II			
Course Type	Core			
Regulation	IARE-R13			
Course Structure	Lectures	Tutorials	Practicals	Credits
	3	-	-	3
Course Coordinator	Mr N.Venkat Rao, Associate Professor, Civil Department			
Team of Instructors	Mr N.Venkat Rao , JSR Prasad, Professor, Civil Department			

I. COURSE OVERVIEW:

The primary objective of this course is to introduce the concept of Rehabilitation as a precise concept, and study how to overcome the defects in regular construction practices, establish their effectiveness in overcoming the problems faced, study their efficiency and memory needs. The course consists of Retrofitting components in addition to adapting new techniques in construction practices. Retrofitting reduces the vulnerability of damage of an existing structure during a future earthquake. It aims to strengthen a structure to satisfy the requirements of the current codes for seismic design. In this respect, seismic retrofit is beyond conventional repair or even rehabilitation. The principles of seismic retrofit refer to the goals, objectives and steps. The steps encompass condition assessment of the structure, evaluation for seismic forces, selection of retrofit strategies and construction. The applications include different types of buildings, industrial structures, bridges, urban transport structures, marine structures and earth retaining structures. The benefits of retrofitting include the reduction in the loss of lives and damage of the essential facilities, and functional continuity of the life line structures. For an existing structure of good condition, the cost of retrofitting tends to be smaller than the replacement cost. Thus, the retrofitting of structures is an essential component of long term disaster mitigation.

II. COURSE PREREQUISITE(S):

Level	Course Code	Semester	Prerequisites	Credits
PG	BST214	II	Concrete Technology	3

III. MARKS DISTRIBUTION:

Subject	SEE Examination	CIA Examination	Total Marks
Rehabilitation & Retrofitting of structure	70 Marks	30 Marks	100 Marks

Semester End Examination (SEE):

The SEE Conducted for 70 marks of 3 hours duration. The syllabus for the theory courses is divided into FIVE units and each unit carries equal weight age in terms of marks distribution. The question paper pattern is as follows: two full questions with ‘either’ or choice will be drawn from each unit. Each question carries 14 marks.

Continuous Internal Assessment (CIA):

CIA Conducted for a total of 30 marks, with 25 marks for continuous internal Examination (CIE) and 05 marks for Quiz/Alternative Assessment Tool (AAT).

Continuous Internal Examination (CIE):

The CIE exam is conducted for 25 marks of 2 hours duration consisting of two parts. Part-A shall have five compulsory questions of one mark each. In part-B, four out of five questions have to be answered where, each question carries 5 marks. Marks are awarded by taking average of marks scored in two CIE exams.

Quiz/ Alternative Assessment Tool (AAT):

Two Quiz exams shall be online examinations consisting of 20 multiple choice questions and are to be answered by choosing the correct answer from a given set of choices (commonly four). Marks shall be awarded considering the average of two quizzes for every course. The AAT may include seminars, assignments, term paper, open ended experiments, micro projects, five minutes video and MOOCs.

IV. DELIVERY / INSTRUCTIONAL METHODOLOGIES

√	CHALK & TALK	√	QUIZ	√	ASSIGNMENTS	√	MOOCs
√	LCD/PPT	√	SEMINARS	√	MINI PROJECT	√	VIDEOS
√	OPEN ENDED EXPERIMENTS						

V. ASSESSMENT METHODOLOGIES – DIRECT

√	CIE XAMS	√	SEE EXAMS	√	ASSIGMENTS	√	SEMINARS
√	LABORATORY PRACTISES	√	STUDENT VIVA	√	MINI PROJECT	√	CERTIFICATION
√	TERM PAPER						

VI. ASSESMENT METHODOLOGIES – INDIRECT

√	ASSESSMENT OF COURSE OUTCOMES (BY FEEDBACK, ONCE)	√	STUDENT FEEDBACK ON FACULTY (TWICE)
√	ASSESSMENT OF MINI PROJECTS BY EXPERTS		

VII. COURSE OBJECTIVES:

The course should enable the students to:

- I. **Identify** the causes of deterioration in structures and suggest suitable remedial measures.
- II. **Generalize** the types of damages and understand their mechanisms.
- III. **Infer** the causes and prevention mechanisms of corrosion in steel reinforcement and fire induced damages.
- IV. Learn to **inspect** and **assess** the structures using techniques of visual inspection and NDT.

VIII. COURSE LEARNING OUTCOMES:

Students, who complete the course, will have demonstrated the ability to do the following:

BST214.01	Understand deterioration and distress in structures
BST214.02	Identify the condition of structures.
BST214.03	Identify the type of deterioration and method of correction
BST214.04	Understand the general causes of distress
BST214.05	Evaluate causes and prevention methods
BST214.06	Understand the types of damage and damage mechanism
BST214.07	Understand how to handle hardened and fresh concrete
BST214.08	Understand corrosion of reinforcement
BST214.09	Identify the mechanism in corrosion
BST214.10	Analyze the importance of prevention of corrosion
BST214.11	Analyse inspection and testing of concrete
BST214.12	Identify symptoms and diagnosis of distress
BST214.13	Understand the damage assessment
BST214.14	Understand the working of NDT
BST214.15	Importance of repair of structures and common types of repairs
BST214.16	Understand the processes of Gunite ,Shotcrete,Underpinning
BST214.17	Understand the strengthening methods
BST214.18	Recognize the difference between various methods
BST214.19	Understand health monitoring of structures
BST214.20	Analyse the use of sensors
BST214.21	Understand building instrumentation
BST214.22	Recognize the behaviour of sensors
BST214.23	Understand modern sensors and methods

IX. HOW PROGRAM OUTCOMES ARE ASSESSED:

Program Outcomes		Level	Proficiency assessed by
PO1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	H	Assignments/ Exams
PO2	Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	M	Assignments/Exams
PO3	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.	S	Assignments/ Mini Projects
PO4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.	-	-
PO5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.	-	-
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.		-

PO7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.	S	Assignments/ Mini Projects
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	S	Assignments/ Mini Projects
PO9	Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	-	-
PO10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.	M	Group Discussions/ Presentations
PO11	Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.	-	-
PO12	Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	-	-

S – Supportive

H - Highly Related

X. HOW PROGRAM SPECIFIC OUTCOMES ARE ASSESSED:

Program Specific Outcomes		Level	Proficiency assessed by
PSO1	ENGINEERING KNOWLEDGE: Graduates shall demonstrate sound knowledge in analysis, design, laboratory investigations and construction aspects of civil engineering infrastructure, along with good foundation in mathematics, basic sciences and technical communication.	H	Assignments/ Exams
PSO2	BROADNESS AND DIVERSITY: Graduates will have a broad understanding of economical, environmental, societal, health and safety factors involved in infrastructural development, and shall demonstrate ability to function within multidisciplinary teams with competence in modern tool usage.	M	Projects
PSO3	SELF-LEARNING AND SERVICE: Graduates will be motivated for continuous self-learning in engineering practice and/or pursue research in advanced areas of civil engineering in order to offer engineering services to the society, ethically and responsibly.	S	Guest Lectures

S – Supportive

H - Highly Related

XI. SYLLABUS:

UNIT -I
Introduction: Definitions of repair, renovation , restoration, rehabilitation and retrofitting, general understanding of restoration and deterioration and distress in structures –Causes and prevention.–.
Unit - II

Types of Damage, Mechanism of Damage in fresh concrete, harden concrete Mechanism Causes –and Prevention Corrosion of Steel Reinforcement
Unit - III
Inspection and Testing –symptoms and Diagnosis of Distress –Damage assessment –NDT
Unit - IV
Repair of structures –Common Types of Repairs–Repair in concrete structures –Repair in under water structures–Guniting –shot create –underpinning. Strengthening of structures – strengthening Methods – Retrofitting –Jacketing
Unit - V
Health Monitoring of Structures –Use of Sensors –Building Instrumentation

TEXT BOOKS:

1	Maintenance and Repair of Civil Structures, B.L. Gupta and Amit Gupta, Standard Publications.
2	Concrete technology by A.R shanta kumar , Oxford University press.

REFERENCE BOOKS:

1	Defects and Deterioration in Building E F & N Spon, London.
2	Non-Destructive Evaluation of concrete structures by Bungey-Surrey University Press.
3	Concrete Repair and Maintenance illustrated, RS Means Company Inc. W.H. Ranso, (1981)
4	Building Failures: Diagnosis and Avoidance, EF&N spon, London, B.A. Richardson, (1991)

XII. COURSE PLAN:

The course plan is meant as a guideline. There may probably be changes.

Lecture No.	Topic Outcomes	Topics to be covered	References
1-2	Introduction to Rehabilitation and Retrofitting of Structures,	Explain prevention for of Deterioration and distress in concrete Structure.	T1:1.1
3	Differentiating between Rehabilitation and Retrofitting.	Explain Mechanism of damages of concrete structure.	T1:1.4
4	Deterioration of concrete Structure.	Classify Types of damages	T:6.6
5-6	Types of distress in concrete structures in beams, columns.	Identify the Non-Structures damages	T1:3.1
7	Types of causes of Deterioration and distress in concrete Structure.	Identify the Structures damages	T3:3.15
8-9	Types of prevention in R.C.C	Define corrosion of steel reinforcement.	T1:3.3
10-11	Structures like Slabs, Columns, and Beams.	Explain the causes for corrosion of steel reinforcement structures	T1:3.8
12-13	Mechanism of damages of various concrete structure.	Identify the mechanism of corrosion	T1:3.9

14	Types of damages for various R.C.C structures	Discuss the Prevention for corrosion of steel reinforcement structures.	T1:4.3
15-16	Non-Structures damages in building	Define Damage of structure due to fire.	T1:5.9
17-18	Structures damages for various aspects in engineering structures.	Explain Damage of structure due to fire.	T1:5.4
19-20	Determination of corrosion of steel reinforcement in building structures	Designing of fire rating structure.	T1:5.4.1
21-22	causes for corrosion of steel reinforcement structures	Analysis of fire rating structure.	T1:5.6
23-24	mechanism of corrosion and its prevention	Define Phenomena of Desiccation	T1:5.8
25-26	Prevention for corrosion of steel reinforcement structures	Explain Desiccation of fire.	T1:6.9 to 6.10
27	Damage of structure due to fire like loss of life, damage to property	Analysis of inspection.	T1:6.5
28-29-30	Damage of structure due to fire like loss of business, loss of goodwill, Environment pollution.	Calculating testing and monitoring	T1:6.3 to 6.3
31	Designing of fire resistance rating structure, selection of materials, planning of services.	Explain diagnosis of distress.	T1:7.22
32-33	Designing of fire resistance rating structure, horizontal compartmentation, and vertical compartmentation.	Explain diagnosis of distress.	T1:7.22
34-35	Definition Phenomena of Desiccation.	Calculating damage assessment	T1:12.3.2
36-37	Desiccation and its importance in concrete technology.	Explaining of damage assessment	T1:12.6.1
38	Analysis of inspection, Visual inspections, checking originals, in situ testing, laboratory testing.	Explain repair of structure	T1:12.6.2
39-40	Monitoring and testing of structures and their symptoms.	Explain diagnosis of distress.	T:
41-42	Distresses in concrete structures are basic symptoms,.	Calculating damage assessment	T:
43-44	common defects, overloading	Explaining of damage assessment	T1:7.2.1
45-46	Damage assessments for existing structures procedure.	Explain repair of structure	T1:7.4
47-48-49	Assessments of existing structures for corrosion	Discuss common types of repairs	T1:10.2.1

	monitoring techniques.			
50-51-52	Repair of structures with techniques and materials used for repairing of structure.	Define repairs in under water structures.	T1:10.2.4	
53-54	Common types of repairs in structures, repairs in concrete structures are crack repair techniques, sealing with epoxies, routing and sealing, stitching.	Identify Guniting and shot Crete.	T1:10.7	
55-56-57	Repairs in under water structures with termite method.	Define underpinning.	T1:8.4.2	
58-59-60	Guniting and shot Crete discuss with detailed, And materials used for Guniting and shot Crete for repairs.	Define Strengthening of structures	T1:8.8	
61-62	Underpinning of structures various loading, and application and there methodology	Explain Strengthening methods of structures	T1:8.12.2	
XIII.	G 63-64	Strengthening of structures and its components for various constructions of structures.	Identify the Strengthening methods of structures	T1:8.11.3
	A			
	P			
	S 65-66	Strengthening methods of structural members and their different methodologies for beams, columns, slabs.	Construction of jacketing.	T1:8.11.2
I				
N				
T 67-68	Strengthening and stiffening of beams, girders and flexural members.	Explain health monitoring structures	T1:8.12	
H				
E				

SYLLABUS - TO MEET INDUSTRY / PROFESSIONAL REQUIREMENTS:

S NO	DESCRIPTION	PROPOSED ACTIONS	RELEVANCE WITH PO's	RELEVANCE WITH PSO's
1	Understand deterioration and distress in structures	Seminars/Guest Lectures/NPTEL	PO 3, PO 4	PSO 1
2	Inspection and testing of concrete	Seminars/Guest Lectures/NPTEL	PO 1	PSO 1
3	Health monitoring of structures	Seminars/NPTEL	PO 4	PSO 1

XIV. MAPPING COURSE OBJECTIVES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Objectives	Program Outcomes	Program Specific Outcomes
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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
I	S		H	H			S					S	H	S	
II	H		S				S						S		
III	H	S	S										H		
IV	H	S		S									S		S

S – Supportive

H - Highly Related

XV. MAPPING LEARNING OUTCOMES LEADING TO THE ACHIEVEMENT OF PROGRAM OUTCOMES AND PROGRAM SPECIFIC OUTCOMES:

Course Learning Outcomes	Program Outcomes												Program Specific Outcomes		
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
1	H												H		
2	S	H											S		
3														S	
4	H	S											H		
5	S			S					S				S	S	
6	H	H											H	H	
7	H			S					S				H		
8	S			H					H				S		
9	H	H											H		
10	H												H		
11	S	S											S		
12	S						S						S		
13	S	S	S										S		
14	S	H											S		
15	H	H											H	S	S
16	S	S											S		
17				S					S						
18	H	H	S										H		
19	S												S	S	S
20		S													
21	H	S		S					S				H		
22	S												S		
23								S							

S – Supportive

H - Highly Related

XVI. DESIGN BASED PROBLEMS (DP) / OPEN ENDED PROBLEM:

1. Understand deterioration of structures and various methods of corrections
2. Understand mechanism of damage and corrosion of reinforcement
3. Understand repair of structures and strengthening of structures

Prepared by:

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