SUBJECT - DESIGN OF RCC STRUCTURES

Course Name	:	Civil Engineering
Course Code	:	CE / CS / CR / CV
Semester / Year	:	Sixth for CE/CS/CR
Subject Title	:	**Design of RCC Structures**
Subject Code	:	

Teaching and Examination Scheme :

Teaching Scheme			Examination Scheme					
TH	TU	PR	Paper Hrs.	TH	PR	OR	TW	Total
04	-	02	04	100	-	25#	50 @	175

 # - External **@ - Internal** ***** **On Line Examination**

Note :-

1) Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.
2) Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head sessional work (SW).

RATIONALE :

Design of RCC Structures is the subject at Technology Level. The pre-requisite knowledge, skills and competencies for this subject are expected to be achieved by studying the subjects Mechanics of Structures and Theory of Structures in earlier semesters.

Limit State Method is to be used in the design of RCC structures. IS:456-2000 is to be used for analysis and design and IS:875-1987 is to be used for Loading Standards. Analysis and design of building elements like slabs, beams, columns, footings and dog-legged staircase will be useful in structural design of an RCC building. Emphasis is also on preparation and interpretation of structural drawing and detailing. An elementary terminology of earthquake engineering and exposure to ductile detailing as per IS:13920-2002 has been provided through a separate topic.

An introductory topic on prestressed concrete will be useful to acquaint the learner with the another common mode of use of concrete.

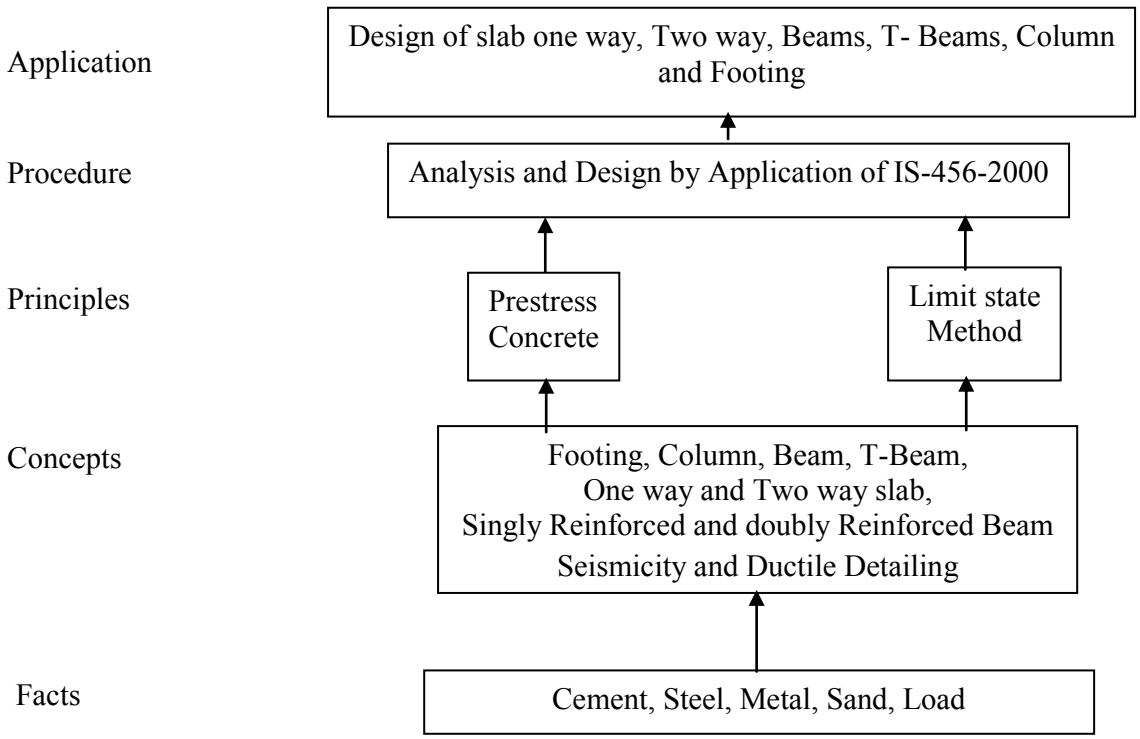
Thus the contents of the subject will be useful to the diploma technician in effective supervision and quality control on site.

OBJECTIVES :

Students will be able to:

1. Understand the basic principles and procedure of design of slab, beam, column and footing of RCC building as per IS:456-2000
2. Understand reinforcement detailing of RCC structural members.
3. Understand design of singly reinforced, doubly reinforced and flanged section of beams, simply supported one way & two way slabs, cantilevers slab, axially loaded columns and footings by limit state method.
4. Understand, read and interpret structural drawings.
5. Understand ductile detailing of structural components of buildings

LEARNING STRUCTURE :



CONTENT : THEORY

Topic and Contents	Hours	Marks
Topic 1 : Introduction to Limit State Method **Specific Objectives** : ➢ State purpose of reinforcement in RCC ➢ Define limit states ➢ Enlist various types of loads on structures **Content :** • Definition of RCC, functions of reinforcement, material properties, use of IS:456-2000 • Definition and types of limit states, partial safety factors for material strength, characteristic strength • Types of loads, use of IS:875-1987, characteristic load, design load	02	04
Topic 2 : Analysis and Design of Singly Reinforced Rectangular Sections by Limit State Method **Specific Objectives** : ➢ Draw strain and stress diagrams ➢ Calculate design constants and ultimate moment of resistance ➢ Design balanced and under-reinforced singly reinforced rectangular sections **Content :** • Limit State of collapse (flexure) : assumptions, stress-strain relationship for concrete and steel, strain diagram and stress block diagram for singly reinforced section, design parameters and constants, ultimate moment of resistance • Under- reinforced, over-reinforced and balanced sections : meaning and comparison • Analysis and design : Numerical problems on determination of design constants, ultimate moment of resistance, ultimate load carrying capacity, design of balanced and under-reinforced sections • IS specifications regarding spacing, cover, minimum reinforcement, effective span, etc. in beams	08	12

Topic and Contents	Hours	Marks
Topic 3 : Analysis and Design of Doubly Reinforced Rectangular Sections by Limit State Method **Specific Objectives** : ➢ Decide whether beam should be designed as doubly reinforced ➢ Draw strain and stress diagram for beams ➢ Calculate ultimate moment of resistance ➢ Design doubly reinforced balanced beams **Content :** • Meaning and conditions for providing doubly reinforced beams • Analysis of doubly reinforced sections : strain and stress diagrams, numerical problems on ultimate moment of resistance • Design of doubly reinforced sections : Numerical problems on balanced design	08	12
Topic 4 : Analysis and Design of Flanged Beams by Limit State Method **Specific Objectives** : ➢ Calculate effective flange width ➢ Determine ultimate moment of resistance ➢ Design flanged beam by carrying out load analysis **Content :** • Meaning and conditions for formation of flanged (T and L) beams, comparison with rectangular beams, effective width of flange • Analysis of singly reinforced flanged beams : Introduction to cases of neutral axis in i) flange and ii) web. Detailed analysis and numerical problems for the case of neutral axis in the flange only • Design of singly reinforced flanged beams : Numerical problems considering loads from supported slabs and walls for simple plans	06	12

Topic and Contents	Hours	Marks
Topic 5 : Shear and Bond by Limit State Method **Specific Objectives** : ➢ Calculate ultimate shear strength of beam ➢ Design beam for shear ➢ Draw reinforcement detailing diagram for shear ➢ Apply check for bond to beams and slabs **Content :** **5.1 Shear :** … (08 marks) Meaning of shear in RCC beams and slabs. IS code specifications. Various forms of shear reinforcement in beams. Use of bent up bars. Zones of minimum shear reinforcement. Numerical problems on design of beams for shear **5.2 Bond :** … (04 marks) Meaning of bond in RCC. IS code provisions. Meaning and calculation development length in tension and compression. Check for bond for simply supported and cantilever beams and slabs	**08**	**12**
Topic 6 : Design of Slabs by Limit State Method **Specific Objectives** : ➢ Decide type of slab from the given plan ➢ Design various types of slabs ➢ Draw reinforcement detailing diagram for slabs **Content :** • Definition and classification of slabs as one-way and two-way slabs, support conditions, main and distribution steel, I.S. specifications regarding spacing and cover for reinforcement, effective span, minimum reinforcement • Limit state of serviceability for slabs : check for deflection • Design of slabs : Procedure and numerical problems on design of one-way simply supported slabs, cantilever slabs, two-way simply supported slabs with corners free to lift and waist slab of dog-legged staircase • Introduction to continuous one-way and two-way slabs : Meaning, advantages and typical reinforcement detailing diagrams (No numerical problems)	**12**	**16**

Topic and Contents	Hours	Marks
Topic 7 : Design of Columns and Footings by Limit State Method **Specific Objectives** : ➢ Calculate ultimate load carrying capacity of a given axially loaded column ➢ Design a column and draw reinforcement detailing ➢ Design isolated sloped footing and draw reinforcement detailing **Content :** **7.1 Axially Loaded Short Columns** … (12 marks) • Limit state of collapse in compression : assumptions, minimum eccentricity, slenderness ratio, short and long columns, calculation of ultimate load carrying capacity of axially loaded short rectangular and circular columns • Load analysis for a column : calculation of load on an axially loaded column from beams at a floor and at various floor levels in a building • Design of axially loaded short rectangular and circular columns : problems on design as per IS specifications for minimum and maximum reinforcement, transverse reinforcement, cover, etc. • Reinforcement detailing at the floor to floor joints **7.2 Axially Loaded Footings** … (04 marks) • Introduction to various types of RCC footings like isolated stepped and sloped footings, combined footings, piles • Design of isolated square sloped footing : Flexural design with checks for one-way shear, two-way shear and bond. (*Problems on design of footing for bending moment only in theory examination paper*)	08	16
Topic 8 : Seismicity and Ductile Detailing **Specific Objectives** : ➢ Define basic terms in seismicity ➢ Draw ductile detailing diagrams for common RCC members as per IS:13920-2002 **Content :** • Definition, magnitude and intensity of earthquake. Zones • Earthquake damages to RCC Buildings like bond failure, shear cracking, slab tearing. Remedies • Ductile Detailing Provisions in IS:13920-200	**04**	**04**

Topic and Contents	Hours	Marks
Topic 9 : Introduction to Prestressed Concrete **Specific Objectives :** ➢ Compare prestressed concrete with RCC ➢ Distinguish between pre-tensioning and post-tensioning ➢ Enlist losses of prestress **Content :** ▪ Meaning of prestressed concrete, comparison with RCC. Advantages and disadvantages of prestressed concrete. ▪ Methods of prestressing, pretensioning and post-tensioning ▪ Losses of prestress : meaning and list of losses (*No numerical problems shall be asked in written examination on this chapter*)	**04**	**04**
Total	**64**	**100**

PRACTICALS

Skills to be developed

Intellectual Skills :

i) Design of structural components
ii) Interpretation of structural drawings

Motor Skills :

i) Preparing structural drawings

Term work shall consist of the following :

1. Mini-project on structural design of a G + 2 framed residential building :

Design of slabs, beams, columns and footings for a simple plan of a G + 2 residential building based on the contents taught in the theory. Students should be encouraged to prepare their own architectural plan otherwise teacher will provide separate data of plan, dimensions and material grades separate for separate groups or batches of students; maximum batch size not exceeding 20.

The students shall submit the design details in the following form :

a) Design Report as included in the Lab. Manual prescribed by MSBTE.
b) Two full imperial size drawing sheets finished in pencils containing i) key-plan ii) reinforcement detailing for sample slabs and beams, column, column

footing of each type and staircase iii) schedules of slabs, beams, columns and footings iv) design notes

2. Study and Interpretation of Professional Structural Drawings :

Professional structural drawings including reinforcement detailing of the components slabs, beams, columns, footings and stair-case shall be collected from nearby consultants. Teacher shall set at least 10 objective questions on each of the five components based on the drawing sheets obtained. Each student shall write the answers in the corresponding exercise in the Lab. Manual of MSBTE.

LEARNING RESOURCES :

Books:

Sr. No.	Author	Title	Publisher
1.	Dr.V.L.Shah & Dr.S.R.Karve	Limit State Theory and Design of Reinforced Concrete Structures	Structures Publications, Pune
2.	N.C.Sinha & S.K.Roy	Fundamentals of Reinforced Concrete	S.Chand & Co., New Delhi
3.	N.Krishna Raju & R.N.Pranesh	Reinforced Concrete Design Principles and Practice	New Age International, Mumbai
4.	S.U.Pillai & Devdas Menon	Reinforced concrete Design	Tata Mcgraw Hill
5.	P. C.Varghase	Limit State Design of Reinforced Concrete	Prentice Hall of India,
6.	N.Krishna Raju	Prestressed Concrete	Tata McGraw Hill, Mumbai
7.	T.Y.Lin	Design of Prestressed Concrete Structures	Wiley India
8.	David Dowrick	Earthquake Resistant Design and Risk Reduction	Wiley India Pvt.Ltd., New Delhi
9.	Steven L. Kramer	Geotechnical Earthquake Engineering	Pearson Education

I.S. Codes:

1. IS 456:2000 - Plain and Reinforced concrete code of Practice
2. SP16- Design Aids for reinforced concrete to IS 456
3. I.S. 875 (Part 1-5) - 1987 code of practice of design loads for Buildings and structures.
4. SP 24 - Explanatory Handbook on IS 456
5. IS 1343-1980 - Indian Standard code of (Reaffirmed 1990) Practice for Prestressed concrete.
6. SP34 : 1987 - Handbook on concrete reinforcement and Detailing.
7. IS 13920-1993 Ductile Detailing of R. C. Building subjected to Seismic forces.

Softwares :

1.struds

2.scadds/nucleus r(200)

3.build master

4.staad.pro.vsi

5.etabs.9.5

1. **Field Visits :**

   Structured field visits can be organized with proper planning to construction sites to view the following points :

   i) Reinforcement detailing of components like slabs, beams, columns, footing, staircase
   ii) Main concreting operations like batching, mixing, transporting, compacting and curing on site
   iii) Stacking of material like cement, sand, metal, steel, etc. on the site
   iv) Formwork for the various components
   v) Cutting and bending of bars on site
   vi) Verification of sample details in the structural drawing with the reinforcement actually provided on site

2. **Development / Use of MS PowerPoint Slide Shows :**

   i) Students can be asked to take digital photographs and videos of the details observed in the field visits. MS PowePoint Slide Shows and MS Movie maker clips can be developed from the photographs and videos by the students as special credit assignments.
   ii) Slide shows on earthquake damages and ductile detailing can be screened

3. **Experts' Lectures / demonstrations :**

   Experts' lecture-demonstration presentations can be organized on the following topics :

   i) Modern site practices
   ii) Use of software packages for design
   iii) Case study of a major construction project

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