INSTITUTE OF AERONAUTICAL ENGINEERING
(Autonomous)
Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

REINFORCED CONCRETE DESIGN LABORATORY								
V Semester: CE								
Course Code	**Category**	**Hours/Week**			**Credits**	**Maximum Marks**		
ACED23	Core	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		-	-	2	1	40	60	100
Contact Classes: Nil	**Tutorial Classes: Nil**	**Practical Classes: 45**				**Total Classes: 45**		
Prerequisite: Computer Aided Engineering Drawing								

I. COURSE OVERVIEW:

The objective of reinforced concrete design laboratory is to determine the forces, stresses, deflections and behaviour of various structural members like beams, columns, arches, trusses and frames when subjected to different types of loadings. This laboratory course will help the students to understand the theoretical concepts learned in the courses solid mechanics and structural analysis I & II and reinforced concrete structures. Laboratory includes experiments and design sessions leading to development of a structural design project in reinforced concrete.

II. COURSE OBJECTIVES:

The students will try to learn:

I. Understand reinforcement details of various concrete members.
II. Produce and interpret reinforcement details of various beams.
III. Develop reinforcement design of columns with lateral ties and spiral reinforcement.
IV. Interpret and produce reinforcement details of slabs, footings and staircase.

III. COURSE OUTCOMES:

At the end of the course students should be able to:

CO 1 Discuss basic concepts of reinforced concrete design, material stress–strain curves, and safety factors to know the properties of concrete structure.
CO 2 Explain the concept of Stress block parameters and use the design concept of working stress method, limit state method for designing different structural components.
CO 3 Explain the concept of bond, anchorage and development length and section for shear and torsion for safe designing of residential, commercial and industrial structures.
CO 4 Solve singly reinforced, doubly reinforced, T, L beam sections as per IS: 456– 2000 for obtaining the reinforcement details in load bearing members.
CO 5 Solve One-way, Two-way, slabs sections as per IS: 456–2000 for obtaining the reinforcement details in load bearing members.
CO 6 Develop the concept of Axial loading uni-axial and bi-axial bending of vertically loaded members, isolated and Combined footing to obtain reinforcement details.

IV. COURSE CONTENT:

EXCERCISES ON REINFORCED CONCRETE DESIGN LABORATORYLABORATORY

1. Getting Started Exercises

1.1 Introduction

Design consists of selecting proper materials, shape and size of the structural member keeping in view the economy, stability and aesthetics. The design of beams are done for the limit state of collapse and checked for the other limit states. Normally the beam is designed for flexure and checked for shear, deflection, cracking and bond.

The main difference between load bearing structure and framed structure is their members who are responsible for bearing and transferring the load to the subsoil. In load-bearing structure, load bearing members are walls, while in a framed structure, load-bearing members are beams and columns.

BEAMS:

A beam is a structural element that primarily resists loads applied laterally to the beam's axis. Its mode of deflection is primarily by bending

COLUMNS:

Columns are defined as vertical load-bearing members supporting axial compressive loads chiefly. This structural member is used to transmit the load of the structure to the foundation. In reinforced concrete buildings beams, floors, and columns are cast monolithically. The bending action in the column may produce tensile forces over a part of cross-section. Still, columns are called compression members because compressive forces dominate their behaviour.

SLABS:

RCC slabs refer to reinforced concrete elements that form horizontal planes or floors in a building's structure. They are typically composed of concrete reinforced with steel bars or mesh, which enhances their load-bearing capacity and resistance to cracking or bending under heavy loads. RCC slabs distribute the weight of the structure evenly, ensuring stability and preventing structural failures.

When it comes to determining the number of steel bars needed, the best bet is to use a bar bending schedule so that you can reduce wastage.

STAIRCASE:

In a public building, the stairs must be from the main entrance itself and located centrally, to provide quick accessibility to the principal apartments.

Try:

To know the reinforcement details of different structural elements of a member and prepare structural drawings for execution of project works.

2. Simply Supported Beams

2.1. Description

A beam is a straight bar element that is primarily subjected to transverse loads. Assuming that the beam is symmetric about y and z axes (with Iyz = 0), the deformed shape of a beam is described by the transverse displacement and slope (rotation) of the beam. Hence, the transverse displacement and rotation at each end of the beam element are treated as the unknown degrees of freedom.

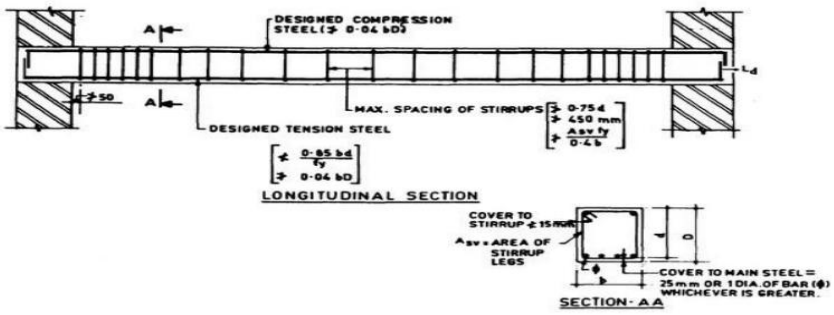


Fig.1 Simply supported beam

Try:

To prepare the reinforcement details drawing for simply supported beam.

3. Continuous Beam

3.1. Description

Continuous beam, i.e. a beam that has more than two supports, is statically indeterminate. The reactions in the supports of a continuous beam cannot be obtained with the equations of static equilibrium only. For the calculation of the reactions in the supports each section is considered as an independent beam.

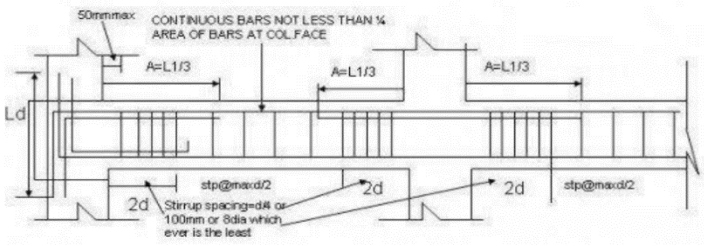


Fig.2 Continuous beam

Try:

To prepare the reinforcement details drawing for continuous beam.

4. T –Beam

4.1. Description

The beam consists of a flange and a rib in the form of a T, generally made of RC concrete or metal is known as T-beam. The top part of the Slab which acts along the beam to resist the compressive stress is called flange. The part which lies below the slab and resists the shear stress is called rib.T-section concrete beams are commonly used in construction, as they are strong and can support a lot of weight.

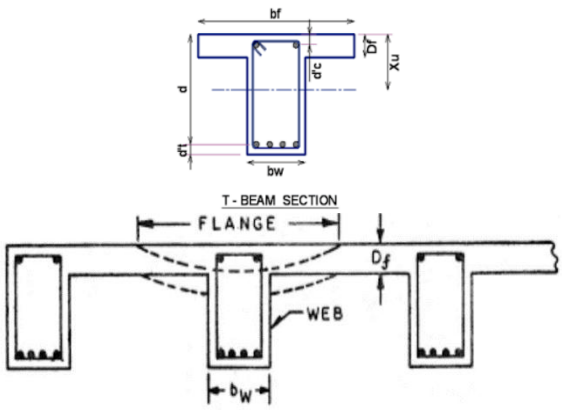


Fig.3 T- beam

Try:
To prepare the reinforcement details drawing for T- beam.

5. Columns with Lateral Ties

5.1. Description

Column is primarily a compression member. The gravity and lateral loads of a structure are transferred to it, which subsequently transfer them to the foundation. Lateral ties stabilize columns by preventing lateral buckling (movement perpendicular) to the column axis where they are attached. If properly designed, lateral ties placed at some vertical spacing along the column's height break the column into several shorter columns.

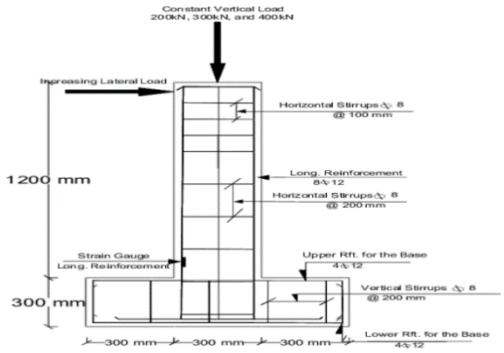


Fig.4 Columns with Lateral ties

Try:
To prepare the reinforcement details drawing for T- beam.

6. Column with Spiral Ties

6.1. Description

A spirally reinforced column has transverse reinforcement in the shape of spiral hoops. A tightly packed continuous spiral organizes the longitudinal reinforcement bars of the spiral column. Spiral columns are usually circular. Spiral reinforcement should be kept perpendicular to the line and firmly in place. Spiral columns are usually circular. Spiral reinforcement should be kept perpendicular to the line and firmly in place. A tied column is one in which smaller diameter transverse bars, commonly known as ties, attach the reinforcing bars at regular intervals.

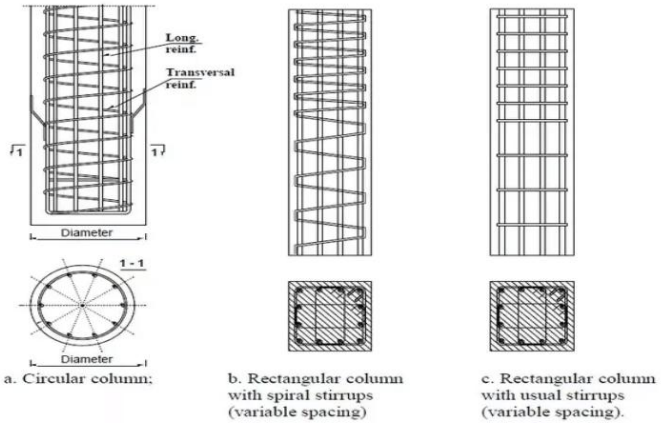


Fig.5 Column with spiral ties

Try:
To prepare the reinforcement details drawing for column with spiral reinforcement.

7. BEAM COLUMN JOINT

7.1. Description

The portion of the column that is common to beam at their intersection in a building is known as the beam column joint. The joints are provided in building construction for continuity of structural action between the members meeting at the joint. In building construction terminologies, the word beam column joint is used to cover elements that have to perform a completely different function.

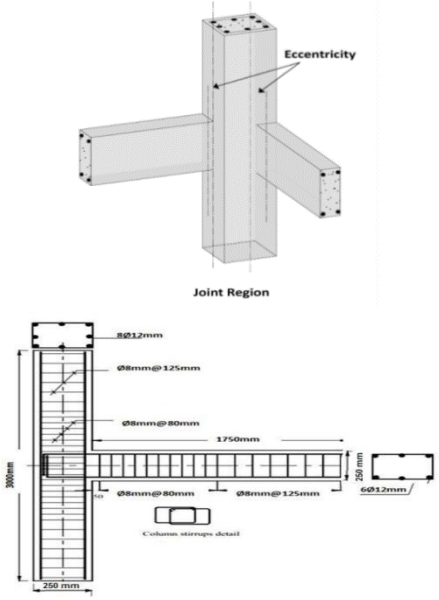


Fig.6 Beam column joint

Try:
To prepare the reinforcement details drawing for beam column joint.

8. SLABS WITH TORSIONAL REINGORCEMENT

8.1. Description

Torsional reinforcement is provided in the form of a grid or mesh both at the top and bottom of the slab. i.e. lx/5. The total area of torsional steel provided in each of the four layers should not be less than: (i) 0.75 Astx(+ve) If both the meeting edges are discontinuous

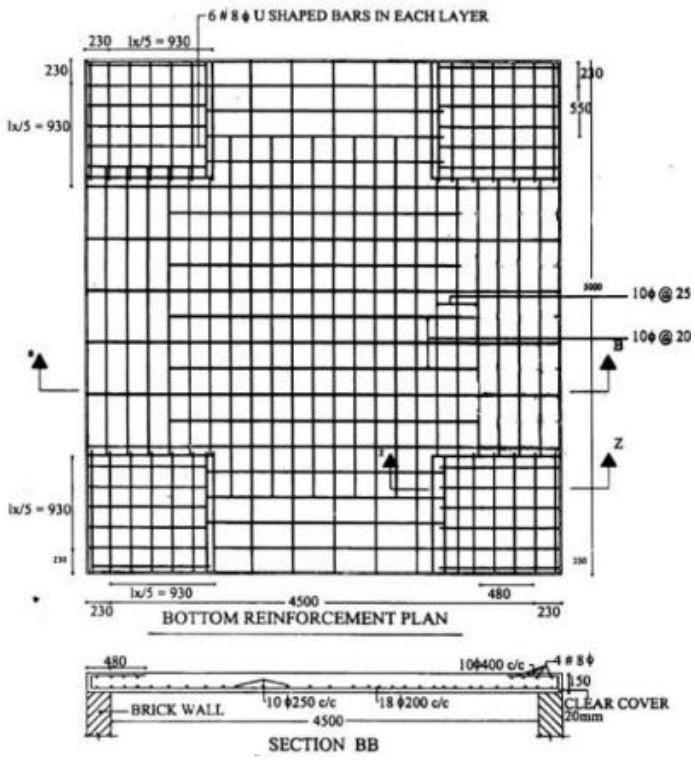


Fig.7 Slabs with torsional reinforcement

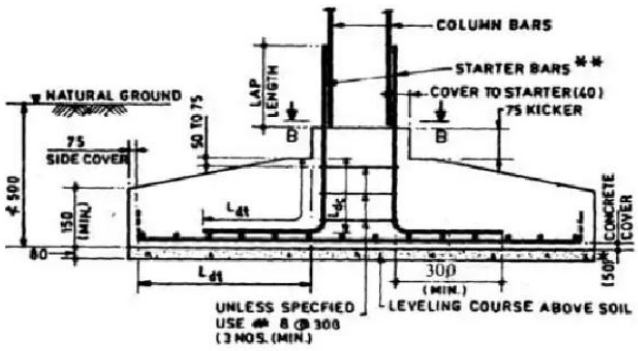
Try:

To prepare the reinforcement details drawing for slabs with torsional reinforcement.

9. FOOTING

9.1. Description

The footing is a structural member that safely transmits the load of the upper building to the ground, and is the first construction member of the building. The basic method of footing design is to distribute the load so that the size per area of the load transmitted from the upper part of the building is less than the strength that the ground can support, that is, the bearing capacity. With this function, the footing is a structure installed between the ground and the column or wall immediately above it, and the important point in the basic design is to reduce the total amount of settlement and prevent the occurrence of immobile settlement.



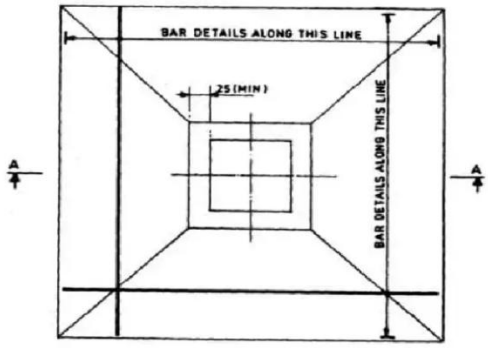


Fig.8 Footing

Try:

To prepare the reinforcement details drawing for footing.

10. PLAN OF R.C.C STAIRCASE

10.1. Description

Stairs consist of steps arranged in a series for purpose of giving access to different floors of a building. Since a stair is often the only means of communication between the various floors of a building, the location of the stair requires good and careful consideration.

In a residential house, the staircase may be provided near the main entrance. In a public building, the stairs must be from the main entrance itself and located centrally, to provide quick accessibility to the principal apartments. All staircases should be adequately lighted and properly ventilated.

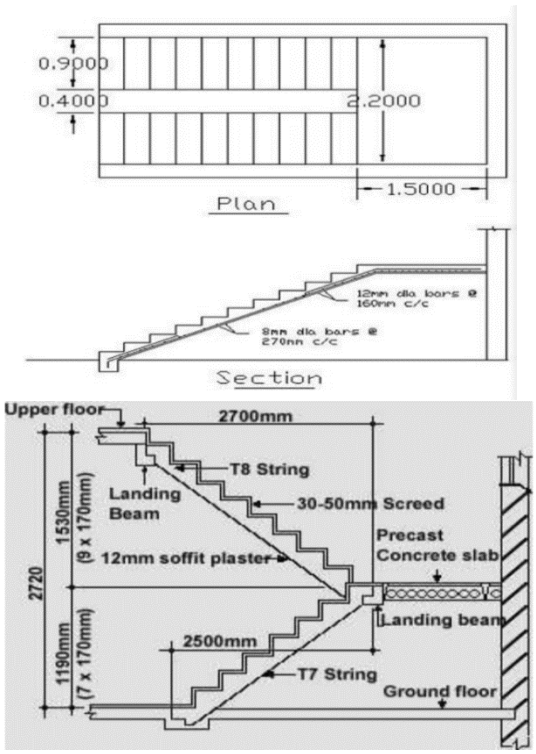


Fig.9 Plan of R.C.C staircase

Try:
To prepare the reinforcement details drawing for R.C.C staircase.

11. REINFORCED CONCRETE CORBEL

11.1. Description

A corbal is a very short structural cantilever member projecting from a wall or column for the purpose of carrying loads. In reinforced concrete structures, corbels are cast monolithically with the walls or columns supporting them. They are found mainly in bridges, industrial buildings, and commercial buildings with precast construction.

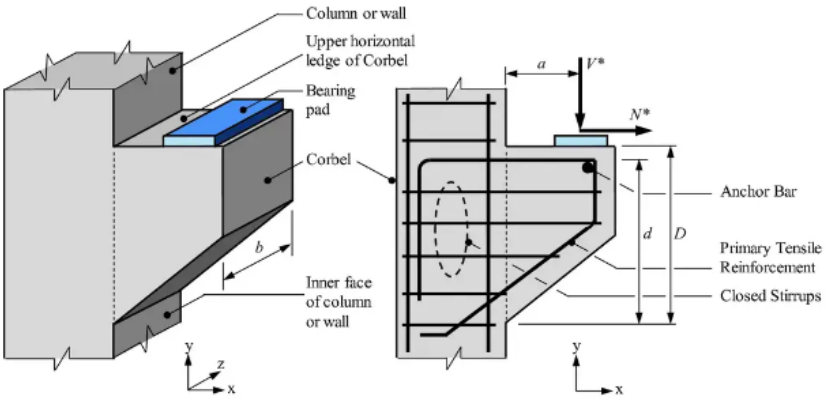


Fig.10 Reinforced concrete corbel

Try:
To prepare the reinforcement details drawing for Reinforced concrete corbel.

12. DUCTILE REINFORCEMENT

12.1. Description

Ductility is a measure of the ability of a material to sustain plastic deformations before collapse. The ductility within a reinforced concrete structure is provided by the steel. Ductility in concrete is defined by the percentage of steel reinforcement with in it. Mild steel is an example of a ductile material that can be bent and twisted without rupture. Member or structural ductility is also defined as the ratio of absolute maximum deformation to the corresponding yield.

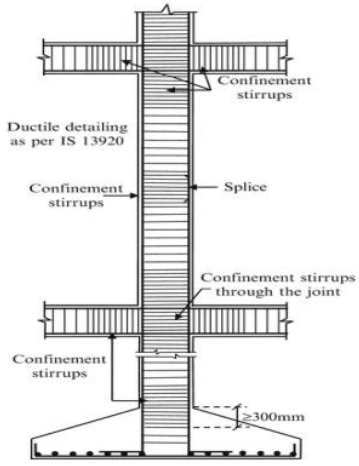


Fig.11 Ductile reinforcement

Try:
To prepare the reinforcement details drawing for Ductile reinforcement.

13. CANTILEVER RETAINING WALL

13.1. Description

There are different types of walls constructed according to the condition of land and function. Retaining walls are built in order to retain the soil masses located at suddenly abruptly changing elevation and provide lateral confinement. The retained mass on another side of these types of walls exerts lateral force and overturning moment to the constructed wall, and thus the wall is needed to design to encounter such forces and moment and safely transfer it to ground strata.

The restoring forces and moment are either provided by self-weight (in case of gravity retaining wall) or by flexural strength of the wall (cantilever and Counterfort retaining wall)

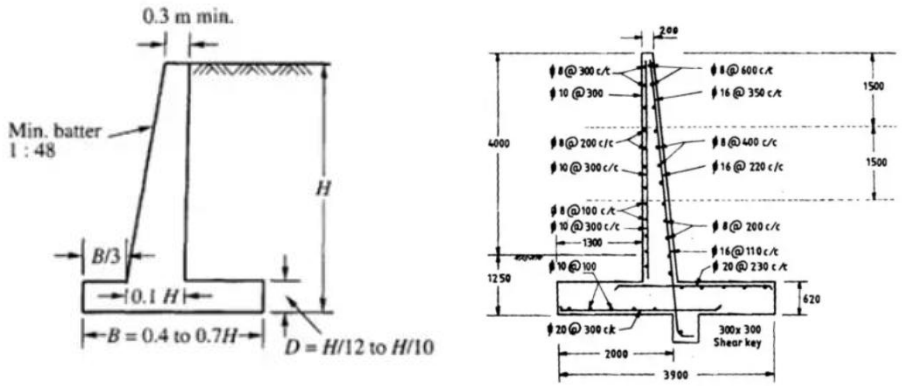


Fig.12 Cantilever retaining wall

Try:
To prepare the reinforcement details drawing for Cantilever retaining wall.

14. ANALYSIS OF PORTAL FRAME

14.1. Description

Portal frames can be defined as two-dimensional rigid frames that have the basic characteristics of a rigid joint between column and beam. The main objective of this form of design is to reduce bending moment in the beam, which allows the frame to act as one structural unit. Precast Concrete Portal Frames are a combination of two columns and a normal beam with additional bending strength, to form a U shape. Units are designed for individual projects meaning the entire Portal Frame structure can be tailored to exact customer specifications.

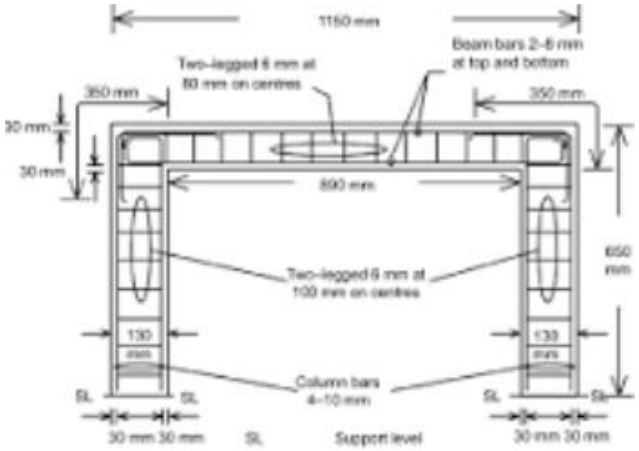


Fig.13 Portal frame

Try:

To prepare the reinforcement details drawing for portal frame.

V. TEXTBOOKS:

1. Bhash C Sharma & Gurucharan Singh, "*Civil Engineering Drawing*", Standard Publishers, 2005.
2. Ajeet Singh, "*Working with AUTOCAD 2000 with updates on AUTOCAD 200I*", Tata Mc Graw-Hill Company Limited, New Delhi, 2002.
3. Sham Tickoo Swapna D, "*AUTOCAD for Engineers and Designers*", Pearson Education, 2009.
4. Balagopal and Prabhu, "*Building Drawing and Detailing*", Spades publishing KDR building, Calicut, 1987.

VI. REFERENCE BOOKS:

1. Malik R.S., Meo, G.S., "*Civil Engineering Drawing*", Computech Publication Ltd New Asian, 2009.
2. Sikka, V.B., "*A Course in Civil Engineering Drawing*", S. K. Kataria & Sons, 2013.

VII. ELECTRONICS RESOURCES:

1. https://www.academia.edu/4319868/
2. https://utdirect.utexas.edu/apps/student/coursedocs/nlogon/download/10531981
3. https://www.researchgate.net/publication/337417423_Laboratory_Tests_Analysis_of_Reinforced_Concrete_Structures_Strengthened_with_CRFP
4. https://utdirect.utexas.edu/apps/student/coursedocs/nlogon/download/10531981

VIII. MATERIAL ONLINE:

1. Course Outline Description
2. Lab Manual