

DESIGN OF RCC STRUCTURES

ENCE 352

Lecture : 4
Tutorial : 2
Practical : 2

Year : III
Part : II

Course Objectives:

The objective of this course is to equip students with the knowledge and skills needed to design various elements of building structures using reinforced concrete. The course emphasizes the limit state method of design, teaching students how to use structural analysis results to design different components according to relevant code provisions and to properly detail reinforcement. It also covers key aspects of the seismic building code, including the requirements for ductile detailing in reinforced concrete structures.

1 Reinforced Concrete Structures and Design Methods (3 hours)

- 1.1 Concept of RCC structures: Materials, advantages and limitations
- 1.2 Design methods of RCC structures
- 1.3 Characteristic strengths and loads
- 1.4 Design process and basis for design
- 1.5 Overview of relevant codes

2 Working Stress Method (4 hours)

- 2.1 Basic assumption in working stress design
- 2.2 Working load and permissible stresses in concrete and steel
- 2.3 Behavior of beam under loading
- 2.4 Types of reinforced concrete beam and different RC sections
- 2.5 Design of singly-reinforced rectangular beam

3 Limit State Method (5 hours)

- 3.1 Safety and serviceability requirements and different limit states
- 3.2 Design strength of materials and design loads
- 3.3 Idealized stress-strain diagram of concrete and steel
- 3.4 Limit state of collapse in flexure, shear, torsion and compression
- 3.5 Limit state of serviceability in deflection and in cracking
- 3.6 Concept of balanced, under-reinforced and over-reinforced sections

4 Design for Flexure (8 hours)

- 4.1 Flexural behavior of reinforced concrete
- 4.2 Design of rectangular beams
- 4.3 Design of flanged beam sections (T-beams and L-beams)

- 5 Design for Shear, Torsion and Bond (6 hours)**
- 5.1 Shear stress in beams
 - 5.2 Behavior of concrete under shear
 - 5.3 Behavior and design strength in torsion
 - 5.4 Development length
 - 5.5 Anchorage bond
 - 5.6 Flexural bond
- 6 Limit States of Serviceability: Deflection and Cracking (4 hours)**
- 6.1 Elastic theory: Cracked, uncracked and partially cracked sections
 - 6.2 Short-term and long-term deflections
 - 6.3 Control of deflection in design
 - 6.4 Control of cracking in design
- 7 Design of Slabs and Staircase (8 hours)**
- 7.1 Design of one-way and two-way slabs
 - 7.2 Detailing of one-way and two-way slabs
 - 7.3 Design and detailing of longitudinally loaded stairs
- 8 Design of Compression Members: Columns (8 hours)**
- 8.1 Effective length of columns
 - 8.2 Interaction diagrams for columns
 - 8.3 Design of short columns
 - 8.4 Design of long columns
 - 8.5 Reinforcement detailing
- 9 Design of Footings (6 hours)**
- 9.1 Design of spread footing
 - 9.2 Design of isolated footings
 - 9.3 Design of combined footings
 - 9.4 Design of mat foundation
 - 9.5 Introduction to pile caps (Basic concepts)
- 10 Reinforcement Detailing: Codal Provisions (4 hours)**
- 10.1 Requirements for good detailing
 - 10.2 Nominal cover
 - 10.3 Curtailment of flexural reinforcement
 - 10.4 Shear reinforcement
 - 10.5 Splicing of reinforcement
 - 10.6 Anchorage
 - 10.7 Bar bending schedule

11 Earthquake Resistant Design and Provisions for Ductile Detailing (4 hours)

- 11.1 Damage to RCC structures in earthquake
- 11.2 Philosophy of design of structures in earthquake prone region
- 11.3 Design for strength and ductility
- 11.4 Provision of ductility in building codes
- 11.5 Ductility requirement for beam, column and joints

Tutorial (30 hours)

1. Design and detailing of rectangular and flanged beams in flexure
2. Design and detailing of rectangular and flanged beams in shear/torsion
3. Design for development length in beams
4. Design and detailing of rectangular and flanged beams for serviceability
5. Design and detailing of slabs and staircase
6. Design and detailing of columns
7. Design and detailing of footings
8. Ductile detailing of structural components

Practical/Assignment (30 hours)

1. Testing of a beam in pure bending
2. Testing of a beam in pure shear
3. Testing of a beam in combined bending and shear
4. Practical work on making skeleton of beam-column connection
5. Practical work on making skeleton of beam-slab
6. Individual project on analysis and design elements of a low rise reinforced concrete building with report submission

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapters	Hours	Marks distribution*
1	3	3
2	4	3
3	5	4
4	8	10
5 and 10	10	8
6	4	4
7	8	10
8	8	8
9	6	6
11	4	4
Total	60	60

* There may be minor deviation in marks distribution.

References

1. Jain, A. K. (2002). Reinforced concrete limit state design (Reprint 2009). Roorkee, India: Nem Chand and Bros.
2. Pillai, S. U., Menon, D. (2011). Reinforced concrete design. New Delhi: Tata McGraw-Hill Education Private Limited.
3. Kong, F. K., Evans, R. H. (1987). Reinforced and pre-stressed concrete. London: ELBS.
4. Agrawal, P., Shrikhande, M. (2006). Earthquake resistant design of structures. New Delhi: PHI Learning Private Limited.
5. Dayaratnam, P. (2011). Design of reinforced concrete structures. Oxford & IBH Publishing.
6. Bureau of Indian Standards. (2000). IS 456: Plain and reinforced concrete – Code of practice.
7. Bureau of Indian Standards. (2016). IS 13920: Ductile detailing of reinforced concrete structures subjected to seismic forces – Code of practice.
8. Bureau of Indian Standards. (1987–1993). IS 875 (Parts 1–5): Code of practice for design loads (other than earthquake) for buildings and structures.
9. Government of Nepal. Prevailing building codes and by-laws in Nepal.