



Birla Institute of Technology & Science, Pilani
Hyderabad Campus

SECOND SEMESTER 2021-2022

Course Handout Part-II

Date: 03-01-2022

In addition to part -I (General Handout for all courses appended to the time table) this portion gives further specific details regarding the course.

Course No. : CE G615
Course Title : Earthquake Engineering
Instructor-in-charge : Dr. Mohan S C

Description : Single and multi degree freedom system; seismic risk, causes and effects of earthquakes; seismicity, determination of site characteristics; design earthquakes; earthquake resistant design philosophy; seismic response; earthquake resistant design of structures; detailing for earthquake resistance in concrete and steel structures.

Scope and Objective of the Course:

Earthquakes are one of the most destructive forces that nature unleashes on earth. Since earthquakes are so far unpreventable and unpredictable, the only course open to us is to design and construct the structure in such a manner that the loss of property and life is minimized. The course deals with various aspects of seismic design and construction of buildings, bridge, tanks, chimneys, retaining structures. Now provisions of BIS codes on earthquake engineering are mandatory for any new construction after June 30, 2007. EQ codes and their provisions are to be studied in-depth. Aim of the course is to know the various aspects in the analysis, design and construction in order to produce safe and economical EQ resistant structures.

Text Book (TB):

1. Duggal, S K (2007) "Earthquake Resistant Design of Structures" Oxford University Press.
2. Agarwal, P. and Shrikhande, M. (2006), "Earthquake Resistant Design of Structures" Prentice-Hall of India.

Reference Books (RB):

1. IS: 1893(All parts), 4326, 13827, 13828, 13920, 13938 and other relevant BIS codes
2. Villaverde R. (2009) "Fundamental Concepts of Earthquake Engineering" CPC press.
3. Kramer S.L., (1996) "Geotechnical Earthquake Engineering" Pearson Education.

4. Krishna, J., Chandrasekaran, A.R. and Chandra, B. (1994) "Elements of Earthquake Engineering." South Asian Publisher.
5. Saran, S. (2006), "Soil Dynamics and Machine foundation" 2nd edition, Galgotia Publisher.
6. Web-Resources: <https://www.eeri.org/>, www.nicee.org/, <http://nees.org/>, <https://www.usgs.gov/>, <http://www.asc-india.org/>, <http://www.sciencecourseware.org/eec/Earthquake/>

Course Plan

| Lecture No. | Learning Objective | Topics to be covered | Chapter in TB/RB |
|-------------|--|---|-------------------------|
| 1-3 | Study the basic causes of EQ and Evaluate the size and strength of EQ | Causes of earthquake, seismic waves, magnitude and intensity, Seismic Risk, Seismic hazard in India and development of seismic zoning map. | 1,T1 |
| 4-6 | Determine site characteristics and | EQ ground motion parameters, dynamic soil properties, local site effects | 3,T1 |
| 7-10 | Evaluate liquefaction potential and apply suitable remedial measure | Phenomena of liquefaction and Factors Affecting Liquefaction, Various methods of evaluation of liquefaction. Anti-liquefaction measure. Code of practice. | Lecture Notes |
| 11-14 | Understand the concept and principle of EQ resistant design using Indian Code of practice. | EQ resistant design philosophy, basic principles of EQ resistant design, regular and irregular buildings, reasons of failure during earthquake, Codal provisions of IS: 1893- 2002 (Part-1) for multistoried buildings, torsion response of buildings | IS:1893-Part1 5, T1 |
| 15-17 | Calculate EQ forces on a structure using various methods | Equivalent frame analysis, Response Spectrum method, Time history method of analysis. | 18, T2 IS:1893-Part1 |
| 18-24 | Design and detail of RCC structures as per standard guidelines to satisfy ductility criteria | Causes of failure of RCC structures, case studies. Concept of ductility, Ductile design, Beams, columns, joints, strong columns and weak beams concept. Design and detailing of beam column joint, Design and detailing of RC shear wall. | 8, T1, IS:13920 |

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| 25-26 | Detail steel connections and bracing members for earthquake resistant design | Causes of failure of steel structures, case studies, detailing of steel connections, bracing members. | 9,T1, IS800-2007 |
| 27-29 | Analyze industrial and stack-like structures for seismic loads | Seismic analysis of chimneys, cooling towers, etc. and industrial structures as per Indian Standards | IS1893- Part-4 |
| 30-33 | Analyze water tanks for seismic loads | Seismic analysis of water tanks as per Indian Standards | IS1893- Part-2 |
| 34-35 | Analyze retaining structures for seismic loads | Seismic earth pressure for $c-\phi$ soils, Analysis of Retaining and Reinforced earth wall in seismic region. | IS-1893 Part-3 |
| 36-39 | Apply suitable repair, rehabilitation, retrofit and strengthening techniques for various seismic zones | Seismic retrofit of existing buildings. Repair and seismic strengthening of damaged buildings. | IS:13935 |
| 40-42 | Earthquake Protection Systems | Classification, Principles, applications, and Case Studies | PPT/Lecture Notes |
| | Design and detail of non-engineered structures as per standard guidelines | EQ resistant guidelines and provisions for non-engineered earthen, stone masonry, and brick masonry. | 6, T1 IS:4326, IS:13827,IS:13828 |

6. Evaluation Scheme

| Component | Duration | Weightage | Date & Time | Remarks |
|---------------------|-------------|-----------|--|------------------|
| Mid Semester Exam | 90 min | 25% | As per timetable | Closed/Open Book |
| Assignments (4 No.) | 1 week each | 15% | Continuous | Open Book |
| Seminar (1 No.) | 30 min | 5% | 3 rd to 4 th week of April | Open Book |
| Design Lab (10 No.) | 1 per week | 10% | Continuous | Open Book |
| Projects (1No.) | 2 months | 10% | Continuous | Open Book |
| Comprehensive Exam | 120 min | 35 % | 10/05/22, FN | Closed/Open |

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|--|--|--|--|------|
| | | | | Book |
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7. Academic Honesty and Integrity Policy: Academic honesty and integrity are to be maintained by all the students throughout the semester and no type of academic dishonesty is acceptable.

8. Chamber Consultation Hour: To be announced in the class

9. Notice: Notices will be displayed on Department of Civil Engineering Notice Board and CMS.

Instructor-in-charge