

Earthquake Resistant Design of Structures
01ST1305 (PEC)

Objective of the Course: Objectives of introducing this subject at second year level in Masters of civil engineering are:

- This subject is conceptual applications of principles of dynamics and earthquake resistant design & detailing of RC structures
- To understand the behavior of the structure subjected to earthquake forces and earthquake resistant design of the structure.

Credit Earned: 3

Students learning outcomes:

After successful completion of the course, it is expected that student will be able to

1. Understand the characteristics of earthquake ground motions.
2. Analyze the structure using code based static and dynamic method.
3. Design and detail the structure for seismic load.
4. Understand the concept of Performance Based Design of structures.

Teaching and Examination Scheme

Teaching Scheme (Hours)			Credits	Theory Marks			Tutorial/ Practical Marks		Total Marks
Theory	Tutorial	Practical		ESE (E)	CSE (M)	Internal (I)	Viva (V)	Term Work (TW)	
03	00	03	03	50	30	20	25	25	150

Detailed Syllabus

Sr No.	Title of the unit	Number of hours
1	Introduction of Engineering Seismology & Ground Motion Characteristics	
	<p>Basic of Seismology; Damaged Caused during past earthquakes; Introduction to SLE, DBE & MCE.</p> <p>Time History Records and Frequency Contents of Ground Motion; Far Fault & Near Fault earthquake ground motions & it's characteristics; PGA, PGV, PGD of all major earthquake of India.</p> <p>Introduction to micro zonation study carried out for different parts of India; Introduction to Vulnerability of Buildings, Quantification of Vulnerability; Features which makes buildings vulnerable to earthquakes.</p>	6
2	Philosophy of Earthquake Resistant Design	
	<p>Design Philosophy Design Philosophy of Earthquake-Resistant Design and Construction; Introduction to Capacity Based Design of Building; Earthquake Demand versus Earthquake Capacity; Effects of various structural irregularities in seismic performance of buildings, Effects of Masonry Infill walls in Performance of RC Buildings, Introduction to Lateral Load Distribution & Lateral loads resisting systems. Torsionally Coupled & Uncoupled System.</p> <p>Seismic Analysis & Design of RC Building Development of Structural Frame System from Architectural Plan; Seismic Analysis of Multistoried Building Using Code Based Equivalent Static Analysis as per IS Standards. Introduction to concept of Response Spectrum, the concept of Modal Analysis & Mode shapes of structures, the code based Linear Response Spectrum Analysis Procedure, Seismic Analysis of Multistoried Building Using Code Based Response Spectrum Analysis as per IS Standards. Introduction and Concept of The Time History Analysis of Structures.</p> <p>Ductile Detailing: Impact of ductility; Requirements for ductility; Structural ductility; Factor affecting ductility; Ductility considerations as per IS13920-2016, Ductile Detailing of RC Elements like Beams, Columns, RC Walls, etc. as per IS standards, Beam Column Capacity Ratio. Design of Beam-Column Joint of SMRF, Design & Detailing of Shear Wall & Coupled Shear wall as per Indian Standards.</p> <p>Modelling, Analysis & Design of 3D Multistoried RC Building with design load combinations using Code based Equivalent Static & Response Spectrum Method using commercially available software like STAAD PRO, ETABS, SAP2000 etc.; Mathematical Modelling of Masonry Infill in RC Building as per IS Code. Interpretation & Understanding of Post Processing Results of Seismic Analysis.</p>	26

3	Advanced Topics in Earthquake Resistant Design	10
	<p><i>Displacement Based Design:</i> Introduction to Displacement Based Design, Back-Bone Curve, Modelling for Strength, Stiffness and Ductility,</p> <p><i>Performance Based Design:</i> From Code-based Design to PBD: Basics and Methodology, Structural Performance Objectives, Structural Performance Levels and Acceptance Criteria; Fundamentals of Nonlinear Modeling – Distributed and Lumped Plasticity Approaches – Hysteretic Behaviors, Strength Loss, Cyclic Degradation. Modelling of Structure for Nonlinear Analysis in ETABS/SAP2000, Interpreting & Evaluation of Seismic Performance of Buildings, Understanding the Analysis Results from Nonlinear Analysis.</p>	

Suggested Theory Distribution

The suggested theory distribution as per Bloom's taxonomy is as per follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation					
Remember 10%	Understand 15%	Apply 10%	Analyze 35%	Evaluate 20%	Create 10%

Instructional Method and Pedagogy:

1. Use of Learning Management system like canvas
2. Demonstration through ppt and videos and lectures
3. Brainstorming and group discussion sessions
4. Collaborative learning

Recommended Study Material:

Reference Book:

1. Manish Shrikhande & Pankaj Agrawal; Earthquake resistant design of structures, PHI Publication, New Delhi
2. S.K. Duggal; Earthquake resistance design of structures; Oxford University Press, New Delhi.
3. S. Manohar & S. Madhekar, Seismic Design of RC Buildings: Theory & Practice, Springer, India.
4. T. Paulay, M. J. N. Priestly, Seismic Design of Reinforced Concrete and Masonry Buildings, John Wiley & Sons, Inc.
5. G. R. Reddy, Textbook of Seismic Design-Structures, Piping Systems, and Components, Springer.
6. M. J. N. Priestly, Displacement Based Seismic Design of Structures, IUSS Press.

7. Vagelis Plevris, Performance-Based Seismic Design of Concrete Structures and Infrastructures, Engineering Science Reference; IGI Global.
8. Golesorkhi, R., Joseph, L., Klemencic, R., Shook, D. & Viise, J., Performance-Based Seismic Design for Tall Buildings: An output of the CTBUH Performance-Based Seismic Design Working Group.
9. A.K.Chopra; Dynamics of structures , Pearson, New Delhi.
10. Clough &Penzin; Dynamics of structures.
11. John M.Biggs; Introduction to Structural Dynamics
12. C V R Murthy - Earthquake Tips, NICEE
13. IITK-GSDMA EQ26 – V -3.0 Design Example of a Six Storey Building
14. S S Rao; Mechanical Vibration; Pearson, New Delhi

Web Resource

1. <https://www.nicee.org/EQTips.php>
2. www.nicee.org
3. www.eeri.org
4. www.gsdma.org
5. www.ndma.gov.in
6. www.nptel.iitm.ac.in/courses
