CE 2403 BASICS OF DYNAMICS AND ASEISMIC DESIGN

SUBJECT DESCRIPTION AND OBJECTIVES

DESCRIPTION

Seismic Analysis is a subset of structural analysis and is the calculation of the response of a building (or nonbuilding) structure to earthquakes. It is part of the process of structural design, earthquake engineering or structural assessment and retrofit (see structural engineering) in regions where earthquakes are prevalent.The earliest provisions for seismic resistance were the requirement to design for a lateral force equal to a proportion of the building weight (applied at each floor level). This approach was adopted in the appendix of the 1927 Uniform Building Code (UBC), which was used on the west coast of the USA. It later became clear that the dynamic properties of the structure affected the loads generated during an earthquake. In the Los Angeles County Building Code of 1943 a provision to vary the load based on the number of floor levels was adopted (based on research carried out at Caltech in collaboration with Stanford University and the U.S. Coast and Geodetic Survey, which started in 1937). The concept of "response spectra" was developed in the 1930s, but it wasn't until 1952 that a joint committee of the San Francisco Section of the ASCE and the Structural Engineers Association of Northern California (SEAONC) proposed using the building period (the inverse of the frequency) to determine lateral forces.The University of California, Berkeley was an early base for computer-based seismic analysis of structures, led by Professor Ray Clough (who coined the term finite element). Students included Ed Wilson, who went on to write the program SAP in 1970, an early "Finite Element Analysis" program.

Earthquake engineering has developed a lot since the early days, and some of the more complex designs now use special earthquake protective elements either just in the foundation (base isolation) or distributed throughout the structure. Analyzing these types of structures requires specialized explicit finite element computer code, which divides time into very small slices and models the actual physics, much like common video games often have "physics engines". Very large and complex buildings can be modeled in this way (such as the Osaka Internation Convention Center).

OBJECTIVES:

The main objective of this course is to introduce to the student the phenomena of earthquakes, the process, measurements and the factors that affect the design of structures in seismic areas. This objective is achieved through imparting rudiments of theory of vibrations necessary to understand and analyse the dynamic forces caused by earthquakes and structures. Further, the student is also taught the codal provisions as well as the aseismic design methodology

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UNIT I THEORY OF VIBRATIONS 9

Concept of inertia and damping – Types of Damping – Difference between static forces and dynamic excitation – Degrees of freedom – SDOF idealisation – Equations of motion of SDOF system for mass as well as base excitation – Free vibration of SDOF system – Response to harmonic excitation – Impulse and response to unit impulse – Duhamel integral

UNIT II MULTIPLE DEGREE OF FREEDOM SYSTEM 9

Two degree of freedom system – Normal modes of vibration – Natural frequencies - Mode shapes - Introduction to MDOF systems – Decoupling of equations of motion – Concept of mode superposition (No derivations).

UNIT III ELEMENTS OF SEISMOLOGY 9

Causes of Earthquake – Geological faults – Tectonic plate theory – Elastic rebound – Epicentre – Hypocentre – Primary, shear and Raleigh waves – Seismogram – Magnitude and intensity of earthquakes – Magnitude and Intensity scales – Spectral Acceleration - Information on some disastrous earthquakes

UNIT IV RESPONSE OF STRUCTURES TO EARTHQUAKE 9

Response and design spectra – Design earthquake – concept of peak acceleration – Site specific response spectrum – Effect of soil properties and damping – Liquefaction of soils – Importance of ductility – Methods of introducing ductility into RC structures.

UNIT V DESIGN METHODOLOGY 9

IS 1893, IS 13920 and IS 4326 – Codal provisions – Design as per the codes – Base isolation techniques – Vibration control measures – Important points in mitigating effects of earthquake on structures.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Chopra, A.K., "Dynamics of Structures – Theory and Applications to Earthquake Engineering", Second Edition, Pearson Education, 2003.

REFERENCES

1. Biggs, J.M., "Introduction to Structural Dynamics", McGraw–Hill Book Co., N.Y., 1964
2. Dowrick, D.J., "Earthquake Resistant Design", John Wiley & Sons, London, 1977
3. Paz, M., "Structural Dynamics – Theory & Computation", CSB Publishers & Distributors, Shahdara, Delhi, 1985
4. NPEEE Publications.

MICRO LESSON PLAN

WEEK	HOURS	LECTURE TOPICS	TEXT / REFER BOOKS
UNIT I – THEORY OF VIBRATIONS			
I	1	Concept of inertia and damping	R-3
	2	Types of damping	
	3	Difference between static forces and dynamic excitation	
	4	Degrees of freedom(AV class)	
	5	SDOF idealisation	
II	6	Equations of motion of SDOF system for mass as well as base excitation	
	7	Free vibration of SDOF system	
	8	Response to harmonic excitation	
	9	Impulse and response to unit impulse-Duhamel integral	
UNIT II – MULTIPLE DEGREE OF FREEDOM SYSTEM			
III	10	Two degree of freedom system	R-3
	11	Normal modes of vibration	
	12	Natural frequencies	
	13	Mode shapes	
	14	Forced vibration without damping	
IV	15	Introduction to MDOF systems (AV class)	
	16	Decoupling of equations of motion	
	17	Concept of mode superposition(No derivations)	
	18	Forced vibrations with damping	
UNIT III – ELEMENTS OF SEISMOLOGY			
V	19	Causes of earthquake ,Geological faults	R-2
	20	Tectonic plate theory	
	21	Elastic rebound theory	
	22	Epicentre, Hypocentre,information on some disastrous earthquakes(AV class)	
	23	Primary, shear and raleigh waves	
VI	24	seismogram	
	25	Magnitude and intensity of earthquakes	
	26	Magnitude and intensity scales	
	27	Spectral acceleration.	
UNIT IV – RESPONSE OF SRUCTURES TO EARTHQUAKE			
VII	28	Response spectra	R-2
	29	Design spectra	
	30	Design earthquake	
	31	Concept of peak acceleration	
	32	Site specific response spectrum	

VIII	33	Effect of soil properties and damping(AV class)	
	34	Liquefaction of soils	
	35	Importance of ductility	
	36	Methods of introducing ductility into RC structures.	R-2
UNIT V – DESIGN METHODOLOGY			
IX	37	IS 1893 Codal provisions	R-2
	38	IS 13920 Codal provisions	
	39	IS4326 Codal provisions	
	40	Design as per the codes	
	41	Design examples	
X	42	Design examples	
	43	Base isolation techniques(AV class)	
	44	Vibration control measures	
	45	Important points in mitigating effects of earthquake on structures.	

PREPARED BY

M.AJITHA, AP/CIVIL