

Code No: 07A70104

R07**Set No. 2**

IV B.Tech I Semester Examinations, May 2011
EARTHQUAKE RESISTANT DESIGN
Civil Engineering

Time: 3 hours

Max Marks: 80

Answer any FIVE Questions
 All Questions carry equal marks

1. (a) What do you mean by "Seismic Evaluation"?
 (b) Explain the various techniques in seismic evaluation. [16]
2. (a) What is Brick Nogged Timber Frame Construction?
 (b) Give a neat sketch and indicate the features necessary to be incorporated for seismic resistance for these type of construction. [16]
3. (a) Distinguish between a rectangular shear wall and a coupled shear wall.
 (b) Sketch and show the forces acting on a coupling beam during lateral loading.
 (c) Distinguish between a squat shear wall and a tall shear wall.
 (d) What is the difference in behaviour of squat shear wall compared to a tall shear wall? [16]
4. (a) Indicate 3 examples of plan irregularities in buildings.
 (b) What are the methods available to remedy plan irregularities? [16]
5. The stiffness and damping properties of a mass-spring-damper system are to be determined by a free vibration test; the mass is given as $m = 0.1 \text{ kg-sec}^2/\text{cm}$. In this test the mass is displaced 2.5 cm by a hydraulic jack and then suddenly released. At the end of 20 complete cycles, the time is 3 sec and the amplitude is 0.2 cm. Determine the stiffness and damping coefficients. [16]
6. A rigid disk of mass m is mounted at the end of a flexible shaft as shown in figure 1. Neglecting the weight of the shaft and neglecting damping, derive the Equation of free torsional vibration of the disk. The shear modulus (of rigidity) of the shaft is G . [16]
7. (a) On what basis seismic zones are given in IS 1893:2002?
 (b) How many seismic zones exist in the seismic zoning map of India? What causes natural earthquake?
 (c) A four-storey building located in Chennai has the following particulars. The building is used for residential purposes. The building is founded on hard rock. The total weight of the building is 1000 kN. The plan of the building is 30 m x 30 m with a floor height of 3 m. Compute the seismic base shear.
 (d) How will the seismic base shear get affected if the building is located in Delhi instead of in Chennai, other parameters being the same? [16]

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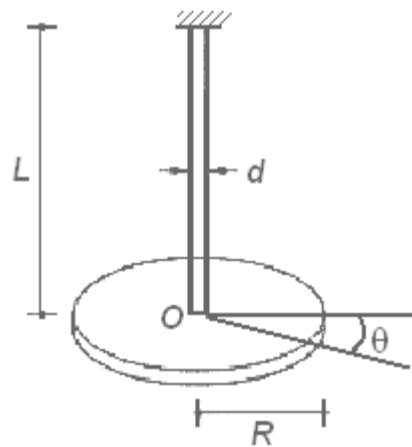


Figure 1:

8. A uniform rigid slab of total mass m is supported on four columns of height h rigidly connected to the top slab and to the foundation slab. Each column has a rectangular cross section with second moments of area I_x and I_y for bending about the x and y axes respectively as shown in figure 2. Determine the equation of motion for this system subjected to rotation $u_{g\theta}$ of the foundation about a vertical axis. Neglect the mass of the columns. [16]

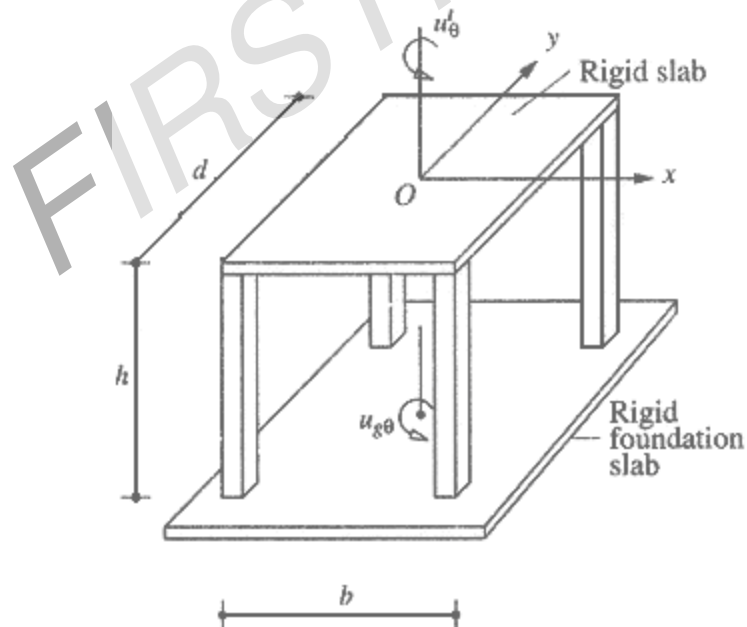


Figure 2:

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R07**Set No. 4**

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1. (a) Indicate 3 examples of plan irregularities in buildings.
(b) What are the methods available to remedy plan irregularities? [16]
2. Define the following using sketches:
 - (a) Boundary elements.
 - (b) Crosstie.
 - (c) Curvature ductility.
 - (d) Hoop reinforcement.
 - (e) Space frame. [16]
3. Develop the equation governing the longitudinal motion of the system of Figure 3. The rod is made of an elastic material with elastic modulus E ; its cross sectional area is A and its length is L . Ignore the mass of the rod and measure u from the static equilibrium position. [16]

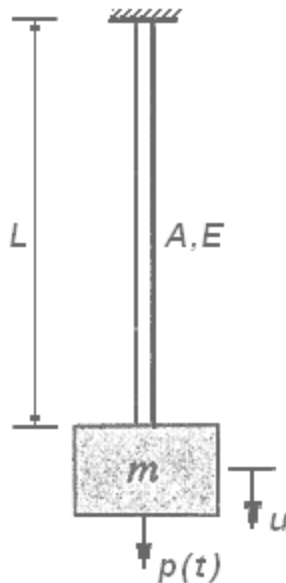


Figure 3:

4. (a) From information recorded during earthquake in 3 seismic stations, describe how epicentre of earthquake is estimated?

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- (b) Distinguish between maximum credible earthquake and design basis earthquake. [16]
5. An SDF system is excited by a sinusoidal force. At resonance the amplitude of displacement was measured to be 5 cm. At an exciting frequency of one tenth the natural frequency of the system, the displacement amplitude was measured to be 0.2 cm. Estimate the damping ratio of the system. [16]
6. A machine weighing 250 kg is mounted on a supporting system consisting of four springs and four dampers. The vertical deflection of the supporting system consisting of four springs the machine is measured as 0.8 cm. The dampers are designed to reduce the amplitude of vertical vibration to one-eighth of the initial amplitude after two complete cycles of free vibration. Find the following properties of the system:
- (a) un-damped natural frequency,
 - (b) damping ratio, and
 - (c) damped natural frequency. Comment on the effect of damping on the natural frequency. [16]
7. A five-storey RC framed structure shown below figure 4 lies in seismic zone II. The height between the various floor levels is 3.5 m and having a total height of 17.5 m. The dead load and live load is lumped at respective floor levels. The soil below the foundation is assumed to be soft soil. The building is intended to be used as a school building. Find the total base shear as per IS 1893:2002. Also distribute the base shear along the height of the building as per IS 1893:2002 recommendations. The plan dimension of the building is 12 m X 24 m.
8. (a) Describe 5 most important features which you would be consider being necessary to make a masonry building earthquake resistant.
- (b) By means of a neat sketch illustrate overall arrangement of reinforcing masonry building with bands for both flat roof and pitched roof buildings? [16]

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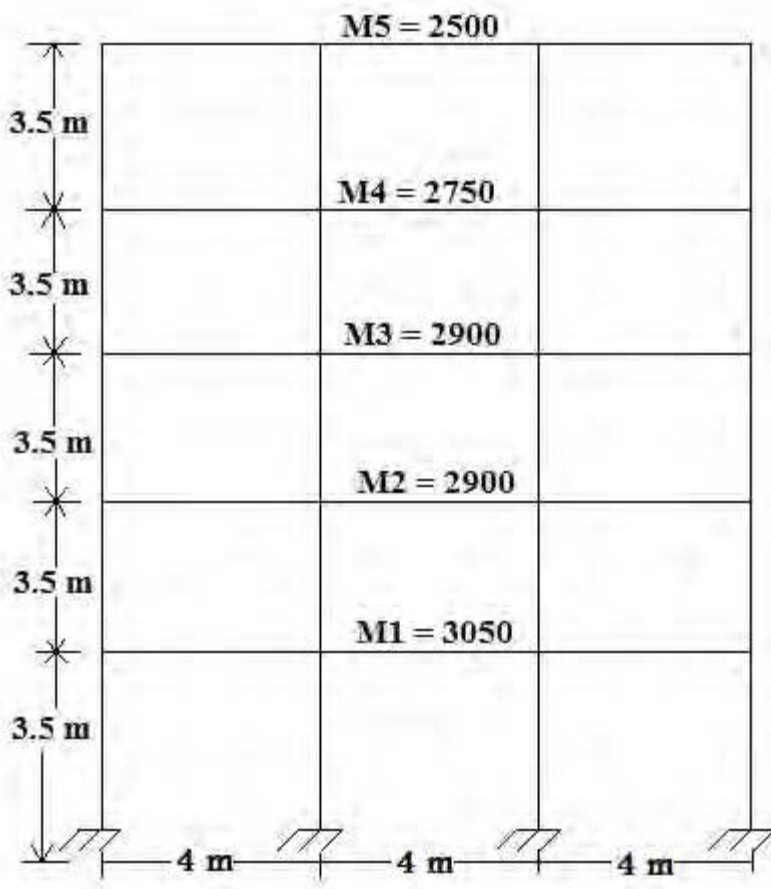


Figure 4:

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1. (a) Indicate 3 examples of vertical irregularities in buildings.
 (b) Why should vertical irregularity cause premature collapse?
 (c) Suggest methods for retrofitting in case of such irregularities. [16]
2. Define the following:
 - (a) Source
 - (b) Hypocentre
 - (c) Focus
 - (d) Liquefaction
 - (e) Fault
 - (f) Foreshock
 - (g) Aftershock. [16]
3. (a) What do you understand by "soft storey"?
 (b) What are the disadvantages of a building with soft storey?
 (c) What are the special precautions you should take while design a building with soft storey as per IS 1893:2002? [16]
4. A rectangular shear wall is of size 300 mm x 5000 mm. It is subjected to factored axial load of 6000 kN and a factored moment of 6000 kN-m. The grade of concrete mix used M 30 and grade of steel used is Fe 500. Design and detail the shear wall as per IS 13920. [16]
5. An SDF system consisting of a weight, spring, and friction device is shown in Figure 5. This device slips at a force equal to 10% of the weight, and the natural vibration period of the system is 0.25 sec. If this system is given an initial displacement of 50 mm. and released, what will be the displacement amplitude after six cycles? In how many cycles will the system come to rest? [16]

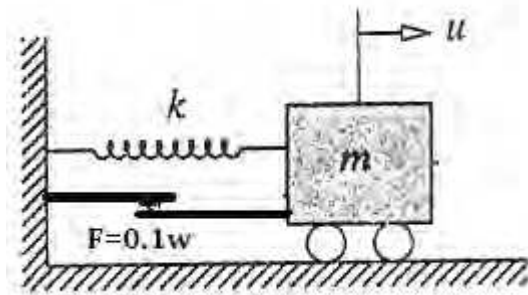


Figure -5

6. A free vibration test is conducted on an empty elevated water tank which is idealized as a single degree freedom system shown in figure 6. A cable attached to the tank applies a lateral (horizontal) force of 16.4 tonnes and pulls the tank horizontally by 5cm. The cable is suddenly cut and the resulting free vibration is recorded. At the end of four complete cycles, the time is 2.0 sec and the amplitude is 2.5 cm. From these data compute the following:

- damping ratio;
- natural period of un-damped vibration;
- effective stiffness;
- effective weight;
- damping coefficient; and
- number of cycles required for the displacement amplitude to decrease to 0.5 cm.

[16]

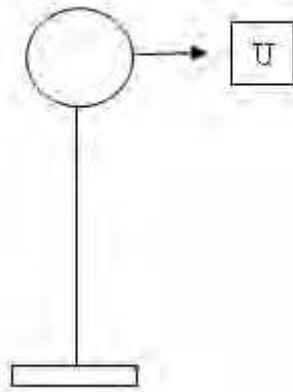


Figure 6:

- Sketch and show reinforcement details of a typical RC band at an L as well as T junction.
 - Does the requirement of reinforcement vary with building category or with span? Comment on your answer with respect to IS 4326:1993. [16]
- Write the equation of motion of the one storey one bay frame shown in figure 7. The flexural rigidity of the beam and columns is as noted. The mass lumped at the beam is m ; otherwise, assume the frame to be mass less and neglect damping. [16]

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Set No. 1

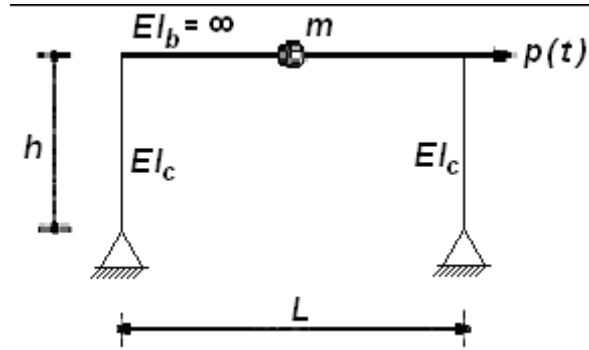


Figure 7

FIRSTRANKER

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1. (a) How are building damages classified? Explain.
(b) What do you understand by seismic intensity?
(c) Distinguish and bring out the difference between intensity and magnitude. [16]
2. Derive the equation of motion of the weight w suspended from a spring at the free end of a cantilever steel beam shown in figure 8. For steel, $E = 2 \times 10^5$ MPa Neglect the mass of the beam and spring. [16]
3. Explain the following in detail using suitable sketches:
 - (a) Vertical discontinuities in load path.
 - (b) Irregularity in strength and stiffness.
 - (c) Torsion irregularities.
 - (d) Re-entrant corner irregularities.
 - (e) Mass irregularities.
 - (f) Plan irregularities.
 - (g) Non parallel system irregularities. [16]
4. An automobile is crudely idealized as a lumped mass m supported on a spring-damper system as shown in figure 9. The automobile travels at constant speed u over a road whose roughness is known as a function of position along the road. Derive the equation of motion. [16]

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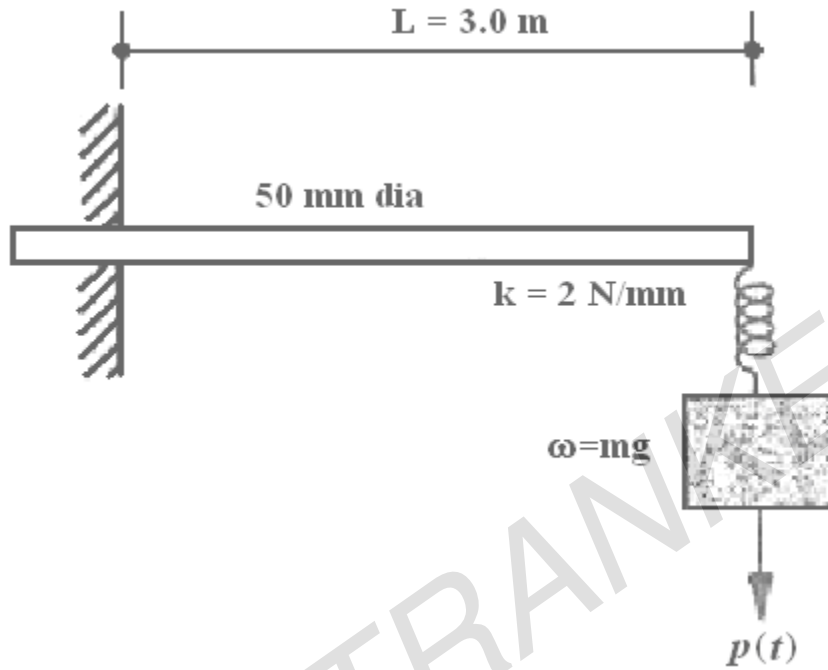


Figure 8:

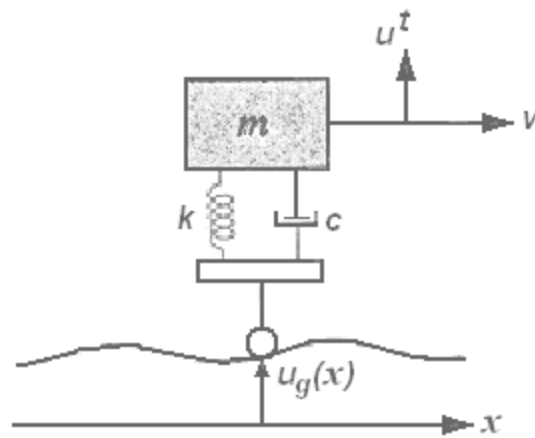


Figure 9:

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5. (a) What do you understand by capacity design?
 (b) A beam 3 m in span has a size 300 mm x 400 mm with a clear cover of 35 mm. The beam is provided with 4 nos 16 mm Φ bars at top as well as bottom as reinforcement. Calculate the flexural capacity of the beam assuming M30 grade concrete and Fe500 grade steel. Using this calculate capacity shear.
 (c) How is design shear arrived from capacity shear? [16]
6. Consider a four-storey RC building shown in figure 10. The building is located in Hyderabad. The soil condition is said to be hard soil and the whole structure is supported on raft foundation. The RC frames are OMRF designed using IS 456. The lumped weight due to dead load is 12.5 kN/m² on floor and 9 kN/m² on roof. The floors are catered for a live load of 4.7 kN/m² and 2 kN/m² on roof. Determine the design seismic load on the structure expressed as nodal loads at joints as per IS 1893:2002 for a typical middle frame along 10 m direction for frame 3. [16]

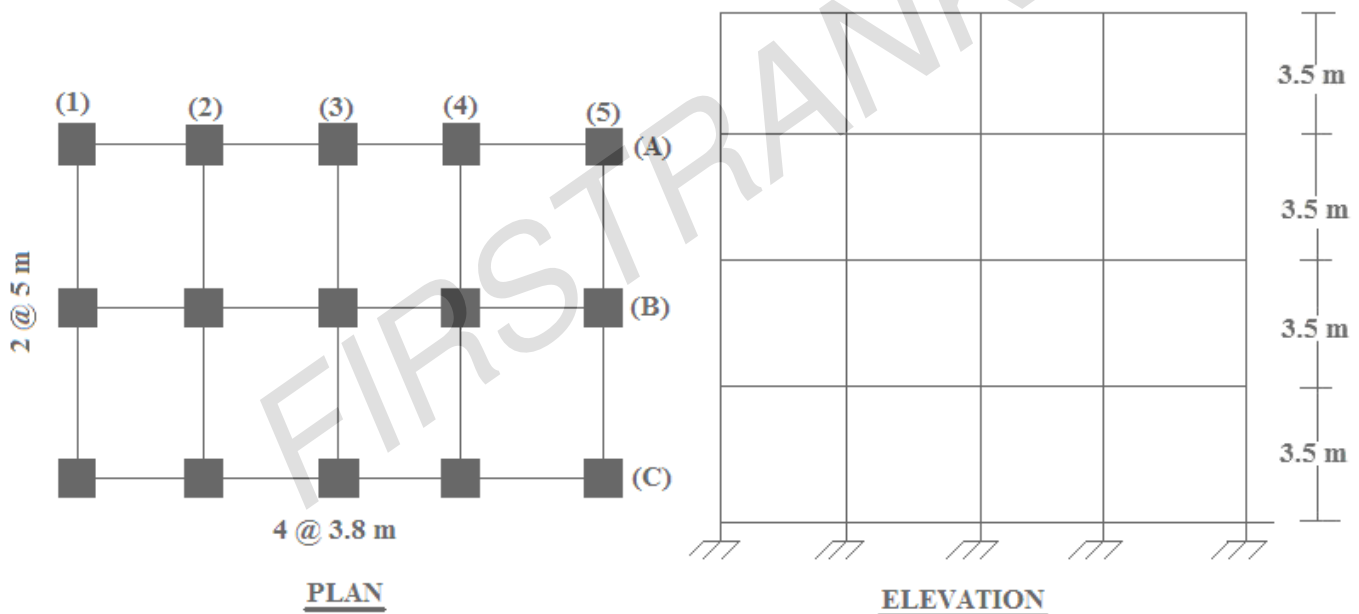


Figure 10:

7. (a) Show that $\omega_r = \omega_n (1 - 2\zeta^2)^{1/2}$ is the resonant frequency of displacement amplitude of an SDF system.
 (b) Determine the displacement amplitude at resonance. [16]
8. A rectangular shear wall is of size 300 mm x 3000 mm. It is subjected to factored axial load of 4000 KN and a factored moment of 4000 KN-m. Design and detail the shear wall as per IS 13920. Use Fe 415 steel and M 25 concrete. [16]
