Group – D

6. (a) Write short notes on the following:
   i. Compressional waves or P waves
   ii. Shear waves or S waves.

   (b) Define seismic intensity and earthquake magnitude.

(3 + 3) + 6 = 12

7. Consider a G + 2 residential building having floor to floor heights 3.0 m each. The depth of foundation is 1.5 m below existing ground level. The mass acting on a typical floor is 20 kN/m^2 dead load and 5 kN/m^2 live load. The roof is not accessible. Find out the seismic base shear acting at the base of the building for all seismic zones of India.

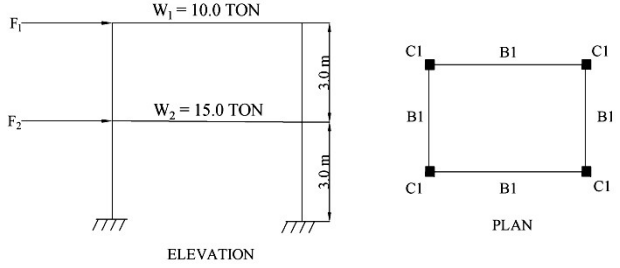
12

Group – E

8. Find out seismic load acting at each floor for a G+4 residential building situated at Kolkata (medium stiff soil site) using Equivalent Static Method. The floor to floor heights are 3.5 m for each floor and the base of foundation is 1.6 m below GL. The plinth height of the building is 600 mm. The total dead load intensity on each floor including roof is 36.5 kN/m^2. The dead load includes selfweigth of slab, floor finish, ceiling plaster, beams and columns. The live load intensity on a typical floor is 2.0 kN/m^2 and on roof 1.5 kN/m^2. The building is 16 m × 20 m on plan and divided by beams @ 4 m c/c. The beams are 250 mm wide and 350 mm deep. Typical floor and roof slabs are 100 mm thick. The columns are 300 mm × 300 mm. Consider the building as OMRF.

12

9. Find out first three natural frequencies and mode shapes for the two storied building shown in figure using Stodola Iteration Technique. The stiffness of columns at first floor is 1.22 × 10^5 TON/m and that of ground floor is 1.46 × 10^5 TON/m. Carry out mass normalization of Eigen vectors (mode shapes) also. C1 = 300 × 300 mm^2 and B1 = 250 × 450 mm^2.



12

STRUCTURAL DYNAMICS & EARTHQUAKE ENGINEERING
(CIVL 4162)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

   (i) A vibrating system consisting of a weight of W=15N and a spring with stiffness k=2N/m. The angular natural frequency of the system is
   (a) 1.14 (b) 5.7 (c) 3.5 (d) 5.0.

   (ii) A mass 2Kg is attached to the end of a spring with stiffness 0.8 kN/m. The critical damping constant is
   (a) 74.92 Ns/m (b) 80 Ns/m (c) 40.7 Ns/m (d) 70 Ns/m

   (iii) The equation of motion for undamped free vibration is:
   (a) $m\ddot{u} + ku = 0$ (b) $m\ddot{u} + c\dot{u} + ku = 0$
   (c) $m\ddot{u} + c\dot{u} + ku = f(t)$ (d) $m\ddot{u} + ku = f(t)$.

   (iv) Logarithimic decreament (δ) is defined as, where Y_1 and Y_2 are two consequtive peaks

   (a) $\delta = \log \frac{Y_1}{Y_2}$, in free vibration (b) $\delta = \ln \frac{Y_2}{Y_1}$, in forced vibration

   (c) $\delta = \ln \frac{Y_1}{Y_2}$, in free vibration (d) $\delta = \ln \frac{Y_2}{Y_1}$, in free vibration

   (v) A vibrating system consists of a mass of 5kg, a spring stiffness of 5N/mm and a dashpot with a damping coefficient of 0.1 N-s/m. The damping ratio is
   (a) 0.413 (b) 0.313 (c) 0.922 (d) 0.612.

(vi) The dynamic magnification factor is defined as the

$(a)\ \frac{Y_{st}}{Y}$ $(b)\ Y \times Y_{st}$ $(c)\ \frac{Y}{Y_{st}}$ $(d)\ \sqrt{\frac{Y}{Y_{st}}}$

Where Y_{st} and Y are the static deflection and steady state amplitude.

(vii) The point where movement occurred which triggered the earthquake is the
(a) Dip (b) Epicenter (c) Focus (d) Strike.

(viii) Body waves consist of the:
(a) P waves only (b) S waves only
(c) P and S waves (d) Surface waves.

(ix) If only density increases with increasing depth within the Earth, the velocity of a P wave should
(a) stay the same (b) increase
(c) decrease (d) becomes zero.

(x) Earthquake A has a Richter magnitude of 7 as compared with earthquake B's 6. The amount of ground motion is one measure of earthquake intensity.
(a) A is 10× more intense than B (b) A is 1000 more intense than B
(c) B is 0.01× as intense than A (d) B is 0.1× as intense than A.

Group – B

2. (a) Define Damping, Natural frequency and mode shape.

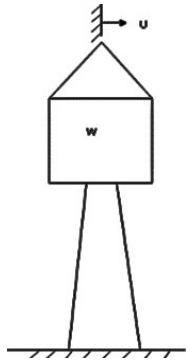
(b) A block of mass 0.0647 kg is suspended from a spring having a stiffness of 50N/m. The block is displaced downwards from its equilibrium position through a distance of 2cm and released with an upward velocity of 3cm/s. Determine (i) the natural frequency (ii) the period of oscillation (iii) the maximum velocity (iv) the maximum acceleration (v) the phase angle.

5 + 7 = 12

3. (a) Discuss the critically damped, underdamped and overdamped systems with relevant graphs and expressions.

(b) The elevated water tower tank with a capacity for 5000 gallons of water shown in fig. has a natural period in lateral vibration of 1.0 sec when empty. When the tank is full of water, its period lengthens to 2.2 sec. Determine the lateral stiffness K of the tower and the weight

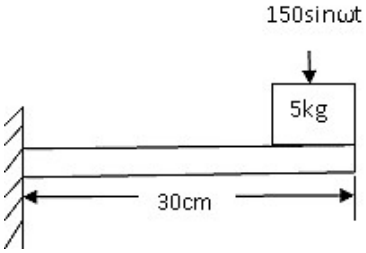
W of the tank. Neglect the mass of the supporting columns (one gallon of water weighs approximately 8.34 lb).



6 + 6 =12

Group – C

4. (a) A 5 kg mass is placed at the end of a 30 cm steel beam as shown in fig. The Young's modulus of elasticity of the steel is 200×10^9 N/m^2 and the moment of inertia of the beam is 1×10^{-8} m^4. When excited by a harmonic excitation of magnitude 150N, vibration amplitude of 0.5 mm is observed. Determine the frequency of the excitation.



(b) A single degree of freedom damped system is composed of a mass of 10kg, a spring having a spring constant of 2000N/m, and a dashpot having a damping constant of 50Ns/m. The mass of the system is acted on by a harmonic force $F=F_0 \sin\omega t$ having a maximum value of 250N and a frequency of 5Hz. Determine the complete solution for the motion of the mass.

6 + 6 = 12

5. (a) What is Duhamel's Integral? Discuss its application in solving structural dynamic problems.

(b) Determine the response of an undamped, single degree of freedom spring mass system subjected to the triangular impulse.

4 + 8 =12