

Master of Construction Engineering 2<sup>nd</sup> Semester Examination 2019

## STRUCTURAL DYNAMICS &amp; EARTHQUAKE ENGINEERING

Assume any relevant data not provided

Answer any Four Questions

1. A Four Storied RCC frame office building located in Kakdwip, West Bengal. The plan of the building is shown below in Fig 1.

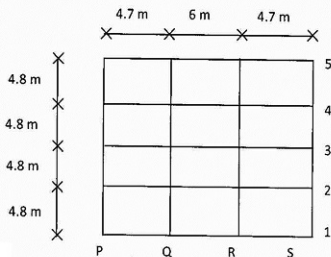


Fig. 1

The soil condition is **soft** and supported on Raft foundation. The RC frames are infilled with brick-masonry. The lump weight due to DL is 12 KN/m<sup>2</sup> on floors and 10.5 KN/m<sup>2</sup> on roof. The Live load on floors is 3 KN/m<sup>2</sup>. Determine the Design seismic Force of the frame 3/P-Q-R-S by **dynamic analysis** method. The free vibration analysis dynamic properties are given below.

Natural Period (S)	Mode 1	Mode 2	Mode 3
	1.25	0.856	0.312
Floor	Mode Shape		
Roof	1.000	1.000	0.712
3 <sup>rd</sup> Floor	0.737	0.394	-0.699
2 <sup>nd</sup> Floor	0.561	-0.555	-0.433
1 <sup>st</sup> Floor	0.340	-0.766	1.000

- 2.
- Discuss **Transient phase & Steady State Motion** in forced vibration? 5
  - Derive the solution for steady state motion of the **SDOF** system under Forced Vibration of  $M\ddot{x} + C\dot{x} + Kx = F_0 \sin \omega_f t$ . 12
  - Derive the expression for **Dynamic Load Factor** and discuss the significance of **Tuning Factor & Critical Damping Ratio** on DLF. 5
  - Evaluate the **D.L.F** when the tuning factor is 0.975 and damping ratio is 2%. 3

- 3 a) Distinguish the salient points between the **Equivalent Static method** and **Response Spectrum method** for seismic design of structure according to Indian code. 10

- b) Calculate natural period, circular frequency of the cantilever beam spanning 0.9 m.  
The member is made of mild steel round section of diameter 50 mm and subjected to a load of 30 kN at the free end as shown in Fig.2. Neglect the mass of the beam. 6

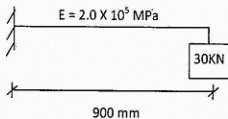


Fig 1

- c) Find also the damped natural frequency of the system with the spring at the end if the critical damping ratio ( $\xi$ ) is 2%. 3

- d) If the cantilever is made of square section mild steel of same cross sectional area calculate the change in time period. 3

- e) If the same cantilever is made with 50 mm diameter round bar made of Aluminium with  $E = 6.9 \times 10^4$  MPa,  $\xi = 2.5\%$ , calculate the change in frequency of the beam. 3

- 4 a) Derive the equation for **Multi Degree Freedom System (MDOF)** of **Shear building model** and discuss frequencies and mode shapes of various modes. 10

- b) Calculate the **natural frequencies and mode shapes** of the following building. 15

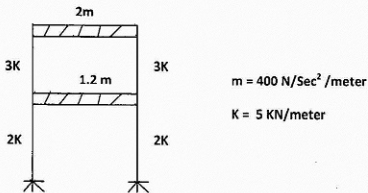


Fig. 3

- 5 a) What do you mean by **damping**? State different damped system 4
- b) Derive **Free vibration solution of an Un-damped SDOF** system 10
- c) Define **Critical Damping Ratio**. Derive the **Logarithmic decrement method**. 11

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|----|---|----|
| 6. | a) What do you mean by <b>Magnitude &amp; Intensity</b> of Earthquakes?   | 5  |
|    | b) Discuss <b>Near field &amp; Far field effect</b> of earthquake on structures.  | 10 |
|    | c) Write down the different <b>Limit States of Safety</b>   | 4  |
|    | d) What are the <b>Basic Safety Objectives</b> from Earthquake considerations?<br>Define <b>Ductility</b> and discuss the role of <b>ductility</b> in achieving the objectives. | 6  |