Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME - SEMESTER– III • EXAMINATION – SUMMER 2015

Subject Code: 732002 **Date: 02/05/2015**

Subject Name: Design of Earthquake Resistant Structure

Time: 2:30 pm to 5:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary**
3. **Figures to the right indicate full marks.**
4. **Assume M20 grade concrete and Fe415 steel unless otherwise specified.**
5. **Use of IS:1893, IS:4326, IS:13920, IS:456 and SP:16 is permitted in examination hall provided they do not contain anything other than the printed matter inside.**

Q.1 **(a)** Answer the followings: **09**

1. List all the load combinations to be considered for a loading with non-orthogonal RC moment resisting frames, if vertical earthquake load and wind load is neglected.
2. Philosophy of Earthquake Resistant Design
3. Discuss in brief how to increase the following for a building in an Earthquake prone area: (a) Period of vibration (b) Energy dissipation capacity (c) Ductility

(b) How the seismic force analysis shall be carried out if a steel tower for cell phone is erected on the terrace of RC frame building? **05**

Q.2 **(a)** List various base isolation system and explain any one with neat sketch **07**

(b) Give stepwise procedure of constructing elastic and inelastic design spectrum. **07**

OR

(b) An internal column of size 500 mm x 500 mm of SMRF is subjected design forces as V_{ux}= V_{uy}= 120 kN, P_u= 2000 kN, M_{ux}=M_{uy}= 300 kNm. It is reinforced with 8-20 mm dia. of main reinforcement. Take Height of floor = 4.5 m and dimension of confining beams is 300 x 500 mm. Design and detail the special confining reinforcement satisfying all criteria of IS: 13920-1993 with neat sketch of longitudinal section. Consider M25 concrete, Fe415 steel and severe environmental exposure as per IS: 456-2000. **07**

Q.3 **(a)** Explain any three structural level (global) retrofit methods for masonry building with neat sketches. **07**

(b) Describe any three member level (local) retrofit methods for RC building with neat sketches. **07**

OR

Q.3 **(a)** Explain the method of determination of performance point in push over analysis. **07**

(b) A reinforced concrete beam of rectangular section of 600 mm effective depth and 300 mm width has to carry a distributed live load of 25 kN/m in addition to dead load of 35 kN/m including its self weight. The maximum bending moment and shear force due to earthquake are 65 kN-m and 60 kN respectively. Centre to centre distance between the supports of the beam is 5.0 m. Design the beam using M25 grade **07**

concrete and Fe 415 steel according to IS: 1893-2002 and IS:13920-1993.

Q.4 Design and detail the shear wall according to IS:1893-2002 and IS:13920:1993 to resist the ultimate axial load Pu = 4100 kN, ultimate bending moment Mu = 9000 kN-m and ultimate shear force Vu = 1200 kN. The clear distance between end block of shear wall = 5.0 m and the size of end block = 550 mm x 550 mm. **14**

OR

Q.4 (a) Assume the Main Steel provided in various beams in Figure 1 as shown in Table-1. Check the safety of column of intermediate storey at location B-3, if it carries factored axial load of 1100 KN and main steel provided is 10 nos. 25 diameter tor steel bars. (Check only main steel and assume stirrups as suitably provided.) Take Floor height = 3.75 m, column dimensions = 300 mm x 500 mm, Beam dimension = 300 mm x 550 mm **14**

Q.5 (a) Calculate base shear and shear force at roof level in y-direction of three storey hospital building consisting of special moment resisting frame resting on medium soil in Bhuj. Consider following data and Figure 2: **07**

- Slab thickness = 150 mm
- Floor finish = 1.0 kN/m^2
- Live load on floor = 5.0 kN/m^2
- Size of beam 230 mm x 600 mm (including slab thickness)
- Consider full height brick walls of 220 mm thickness on beams on outer periphery at all floor except roof floor and no internal wall
- Size of column C_A = 350 mm x 500 mm, C_B = 500 mm x 350 mm and shear wall SW_1 = 100 mm x 1400 mm
- Damping= 10% of critical

Neglect the space occupied by the columns and shear wall in weight calculation.

(b) For the above problem data (Q.5 (a)) calculate joint loads on each frame at roof level due to earthquake in y-direction. **07**

OR

Q.5 (a) Calculate the forces in column due to lateral load of 1800 kN acting in y-direction on a single story building shown in Figure 3. The floor load is 20 kN/m^2 and all columns are square in cross section and of equal height. **07**

If the area ABCD is used for storage purpose, calculate the revised intensity of loading in ABCD portion such that system becomes torsionally uncoupled.

(b) A single degree of freedom system with 35 tones mass, 1800 kN/m stiffness and 5% damping is subjected ground acceleration as shown in Figure 4. Determine the response of the system with 0.2 sec time step. Assume initial displacement and velocity is equal to zero. **07**

Table 1

Beam No.	Continuous Top Bars	Extra Top Bars on Left	Extra Top Bars on Right	Continuous Bottom Bars
B1	2-16 dia.	2-20 dia.	3-20 dia.	6-16 dia.
B2	2-16 dia.	3-20 dia.	3-20 dia.	6-16 dia.
B3	2-12 dia.	2-16 dia.	2-12 dia.	4-12 dia.

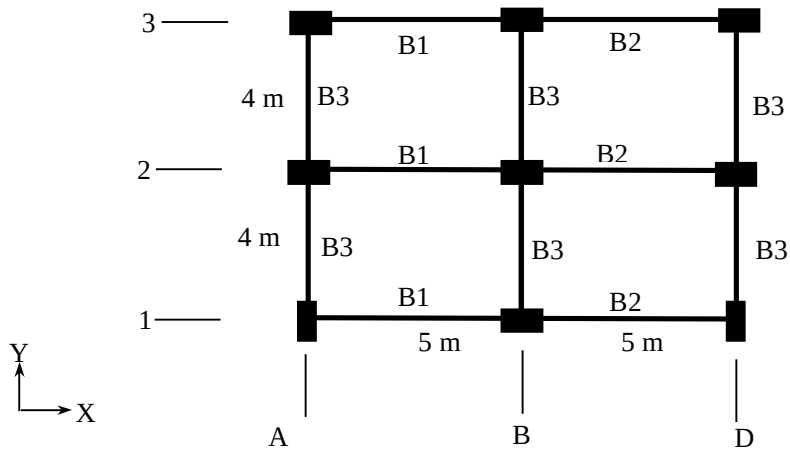

Figure 1 (Typical plan)

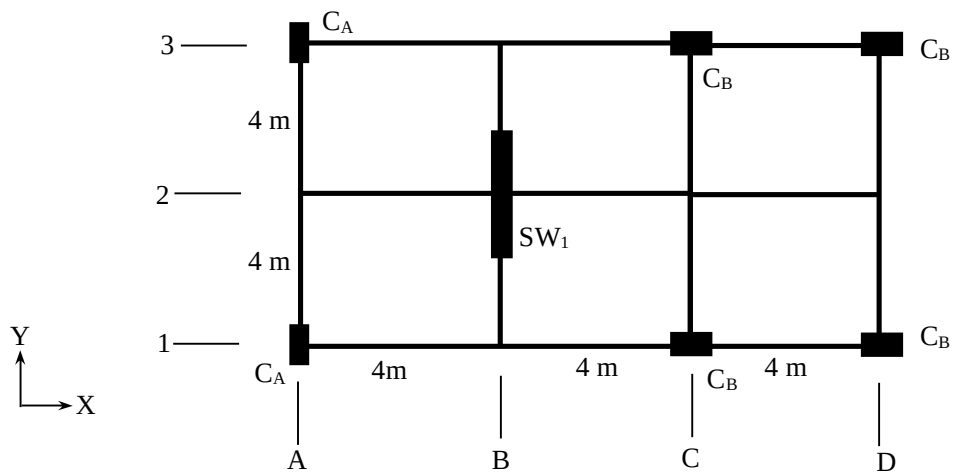

Figure 2 (Typical plan)

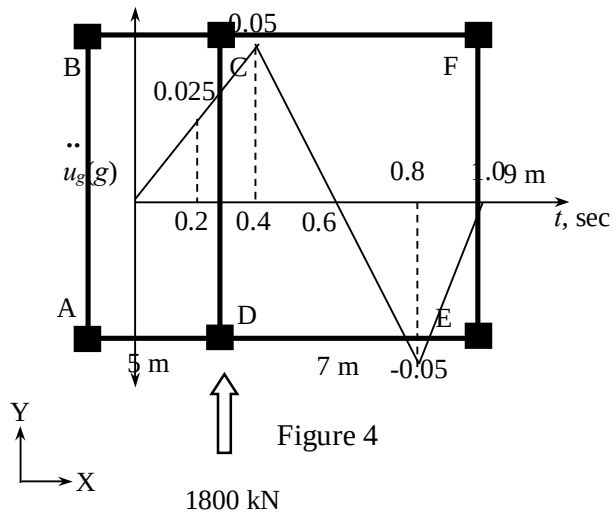

Figure 4

Figure 3