Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER III (OLD) – EXAMINATION – WINTER-2016

Subject Code: 732002 **Date:25/10/2016**

Subject Name: Design of Earthquake Resistant Structure

Time:02:30 pm to 05:00 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. What is irregular building? How does the irregularity affect the seismic performance of building?
2. Capacity design concept of ductile detailing.
3. What is soft story? Why the soft story construction is dangerous in earthquake prone areas.

(b) List various base isolation system and explain any one with neat sketch. **05**

Q.2 **(a)** Explain capacity spectrum method. **07**

(b) Describe any three retrofit methods for masonry building with neat sketches. **07**

OR

(b) Give stepwise procedure of time history analysis using any method for single degree of freedom system. **07**

Q.3 **(a)** Describe methods of retrofitting of RCC beam and footing of a skeletal structure using neat sketches. **07**

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

OR

Q.3 **(a)** Describe various types of dampers used for energy dissipation of seismic energy in a structure. **08**

(b) Define the terms: Repairing, Retrofitting, Strengthening, Rehabilitation, Restoration and Remoulding. **06**

Q.4 **(a)** A reinforced concrete beam of rectangular section of 550 mm effective depth and 300 mm width has to carry a distributed live load of 24 kN/m in addition to dead load of 32 kN/m including its self weight. The maximum bending moment and shear force due to earthquake are 45 kN-m and 35 kN respectively. Centre to centre distance between the supports of the beam is 4.0 m. Design the beam using M25 grade concrete and Fe 415 steel according to IS: 1893-2002 and IS:13920-1993. **07**

(b) An RC column of size 350 mm x 350 mm has 1.2 % reinforcement of its cross sectional area. Design and detail the longitudinal reinforcement of the column satisfying all criteria of IS:13920-1993 and workout the special confining reinforcement as per the code along **07**

with neat sketch of longitudinal section. Consider M20 concrete, Fe415 steel and severe environmental exposure as per IS:456-2000.

OR

Q.4 Design and detail the shear wall according to IS:1893-2002 and IS:13920:1993 to resist the ultimate axial load Pu = 2800 kN, ultimate bending moment Mu = 5000 kN-m and ultimate shear force Vu = 2000 kN. The clear distance between end block of shear wall = 5.6 m and the size of end block = 650 mm x 650 mm. **14**

Q.5 (a) Calculate base shear and shear force at roof level for a small health centre consisting of special moment resisting frame resting on soft soil in Vadodara. Consider following data and Figure 1: **07**

- Slab thickness = 150 mm
- Floor finish = 1.0 kN/m^2
- Live load on floor = 4.0 kN/m^2 and Live load on roof = 1.0 kN/m^2
- Size of beam 230 mm x 550 mm (including slab)
- Consider full height brick walls in ground and first floor with 230 mm thickness on beams around outer periphery and 115 mm thick wall on all other beams
- Size of column C_A = 350 mm x 450 mm, C_B = 450 mm x 350 mm and shear wall SW_1 = 110 mm x 1200 mm

Neglect the self weight and space occupied by the columns and shear wall. Earthquake acts in y-direction.

(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 2500 kN acting in y-direction on a single story building shown in Figure 2. The floor load is 18 kN/m^2 and all columns are square in cross section. **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 50 tones mass, 2200 kN/m stiffness and 5% damping is subjected ground acceleration as shown in Figure 3. Determine the response of the system with 0.1 sec time step. Assume initial displacement and velocity is equal to zero. **07**

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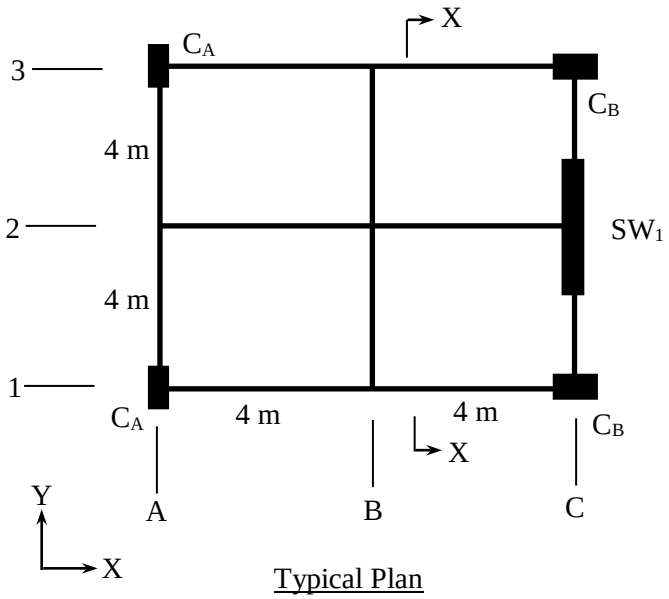


Typical Plan

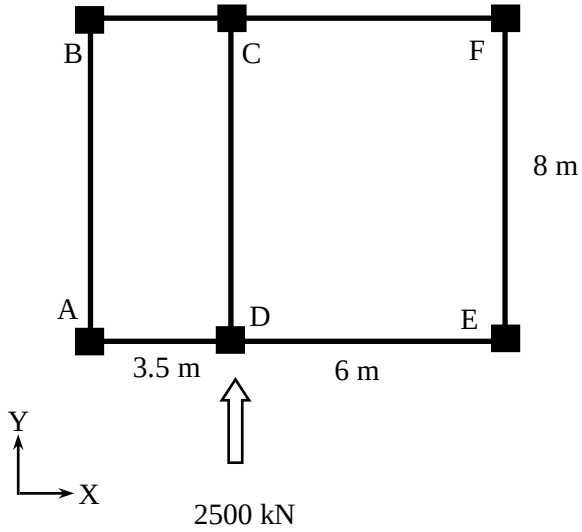
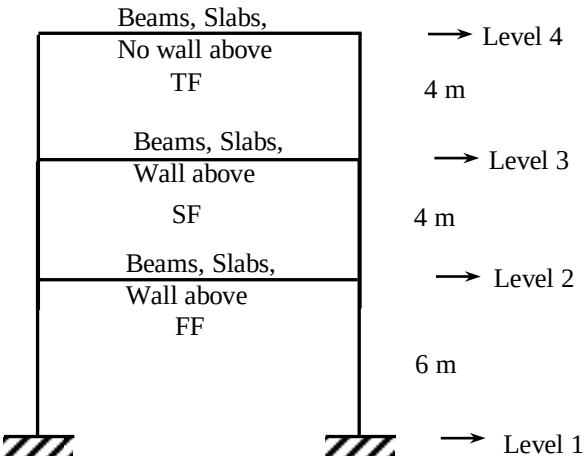


Figure 2



Section XX

Figure 1

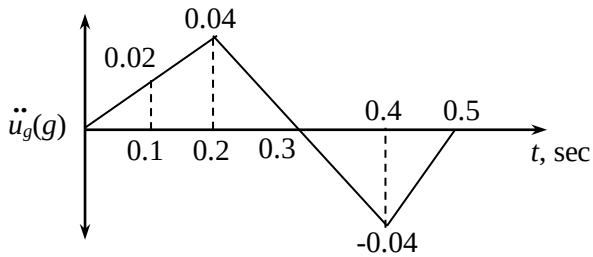


Figure 3