Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M. E. - SEMESTER – III • EXAMINATION – SUMMER • 2013

Subject code: 732002 **Date: 15-05-2013**

Subject Name: Design of Earthquake Resistant Structure

Time: 10.30 am – 01.00 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. Why does the dynamic analysis method yields better results than the equivalent static method?
2. How the seismic force analysis shall be carried out if a steel tower for cell force is erected on the terrace of RC frame building?
3. List all the load combinations to be considered for a lding with non-orthogonal RC moment resisting frames, if vertical earthquake load and wind load is neglected.

(b) Discuss how to increase the following for a building in an earthquake prone area: **05**

(a) Period of vibration
(b) Energy dissipation capacity
(c) Ductility

Q.2 **(a)** Write stepwise procedure of constructing elastic and inelast design spectrum. **07**

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

OR

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

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

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

OR

Q.3 **(a)** Define the terms: Displacement ductility, Repairing, Retrofitting, Soil liquefaction, Restoration, Soft storey, Response reduction factor **07**

(b) Describe the method of retrofitting of beams and columns for RC building with neat sketches. **07**

Q.4 **(a)** Calculate base shear and shear force at roof level of hospital building consisting of special moment resisting frame resting on medium soil in Vadodara. Consider following data and Figure 1: **07**

- Slab thickness = 125 mm

- Floor finish = 1.0 kN/m^2
- Live load on floor = 4.0 kN/m^2
- Size of beam 230 mm x 550 mm (Excluding slab thickness)
- Consider full height brick walls of 230 mm thickness at ground and first floor on beams around outer periphery and no internal walls
- 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 1500 mm
- Amount of damping= 10% of critical damping

Neglect the space occupied by the columns and shear wall for calculation of seismic weight of floors. Assume Earthquake acts in y-direction.

(b) For the above problem data (Q.4 (a)) calculate joint loads on each frame at roof level due to earthquake in y-direction. **07**

OR

Q.4 (a) A RC beam of rectangular section of 550 mm effective depth and 300 mm width has to carry a distributed live load of 20 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 60 kN-m and 35 kN respectively. Centre to centre distance between the su orts of the beam is 5.0 m. Design and detail the longitudinal reinforcement and special confining reinforcement of the beam satisfying all criteria of IS: 1893-2002 and IS:13920-1993. Take M20 grade concrete and Fe 415 steel. **07**

(b) A short column of size 400 mm x 550 mm is subjected to an axial factored load of 900 kN and factored moment about major axis of 250 kNm. Design and detail the longitudinal reinforcement and special confining reinforcement of the column satisfying all criteria of IS: 13920-1993. The column has an unsupported length of 3.0 m and is braced against side sways in both directions. Assume moment due to minimum eccentricity is less than the applied moment. onsider M20 concrete and Fe415 steel. **07**

Q.5 Design and detail the shear wall according to IS: 1893-2002 and IS: 13920:1993 to resist the ultimate axial load Pu = 4500 kN, ultimate bending moment Mu = 9000 kN-m and ultimate shear force Vu = 1700 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.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 20 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 mes torsionally uncoupled.

(b) A single degree of freedom system with 35 tones mass, 1800 kN/m stiffness and 5% damping is subjected ground accelerat 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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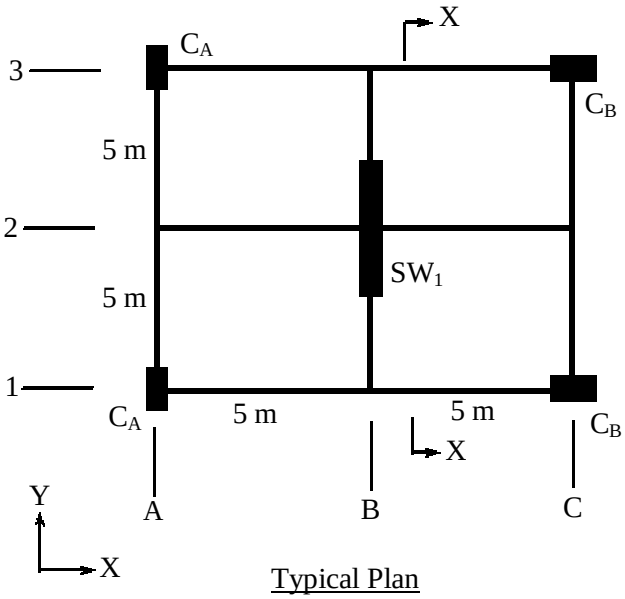

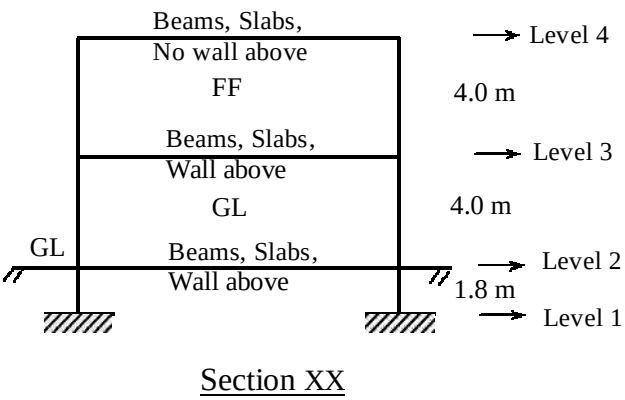

Figure 1

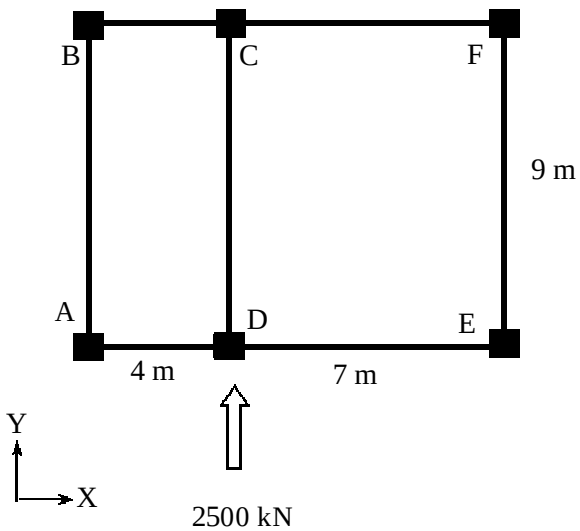

Figure 2

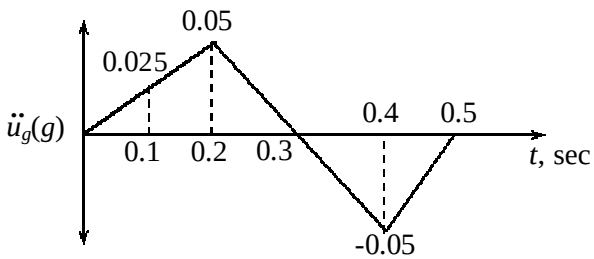

Figure 3