Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

M.E. SEMESTER III–EXAMINATION (Remedial)– WINTER 2015

Subject code: 732002 **Date: 07/12/2015**

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)** Describe the followings: **09**

1. Capacity design concept of ductile detailing.
2. What is floating columns? How does their presence affect the seismic performance of building?
3. Provisions in IS:1893-2002 for design of vertical projections beyond building.

(b) Explain the technique of base isolation with neat sketches along with its application in India. **05**

Q.2 **(a)** Explain the method of determination of performance point in push-over analysis. **07**

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

OR

(b) Give the steps to perform elastic time history analysis using Newmark's method with constant acceleration 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) Explain Design spectrum, Elastic response spectrum and inelastic response spectrum. **07**

OR

Q.3 **(a)** Describe various types of dampers used for energy dissipation of seismic energy in a structure. **06**

(b) Describe any three global retrofit methods for RC building with neat sketches. **08**

Q.4 **(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 1. The floor load is 12 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) An RC column of size 500 mm x 500 mm has 1.8 % 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 with neat sketch of longitudinal section. Consider M25 concrete, Fe415 steel and severe **07**

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 = 3200 kN, ultimate bending moment Mu = 6400 kN-m and ultimate shear force Vu = 1500 kN. The clear distance between end block of shear wall = 6.0 m and the size of end block = 500 mm x 500 mm. **14**

Q.5 (a) Calculate base shear and shear force at roof level for a small shopping complex consisting of special moment resisting frame resting on soft soil in Bhavnagar. Consider following data and Figure 2: **07**

- Slab thickness = 120 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 620 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 500 mm, C_B = 550 mm x 300 mm and shear wall SW_1 = 120 mm x 1000 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) A reinforced concrete beam of rectangular section of 500 mm effective depth and 300 mm width has to carry a distributed live load of 22 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 45 kN-m and 30 kN respectively. Centre to centre distance between the supports of the beam is 4.0 m. Design the beam using M20 grade concrete and Fe 415 steel according to IS: 1893-2002 and IS:13920-1993. **07**

(b) A single degree of freedom system with 40 tones mass, 1800 kN/m stiffness and 5% damping is subjected time varying force at the mass 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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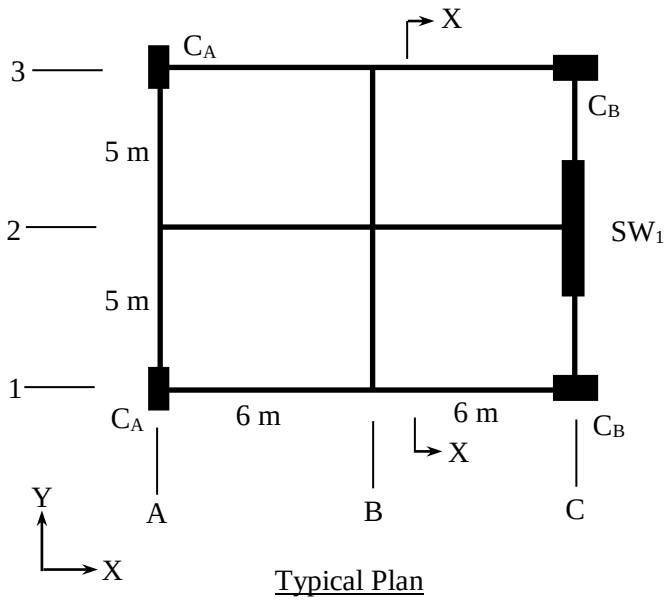

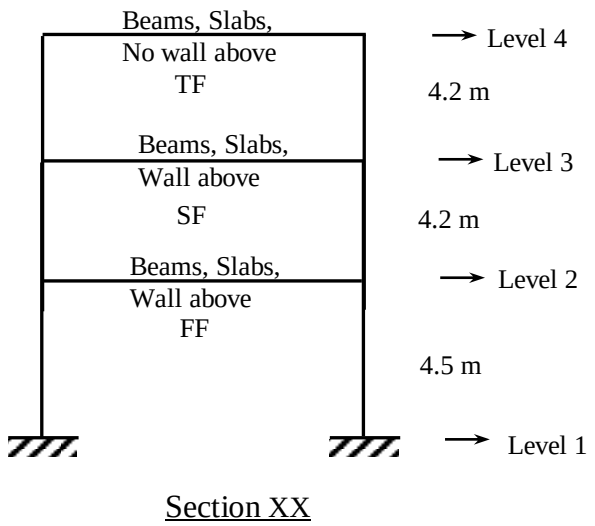

Figure 2

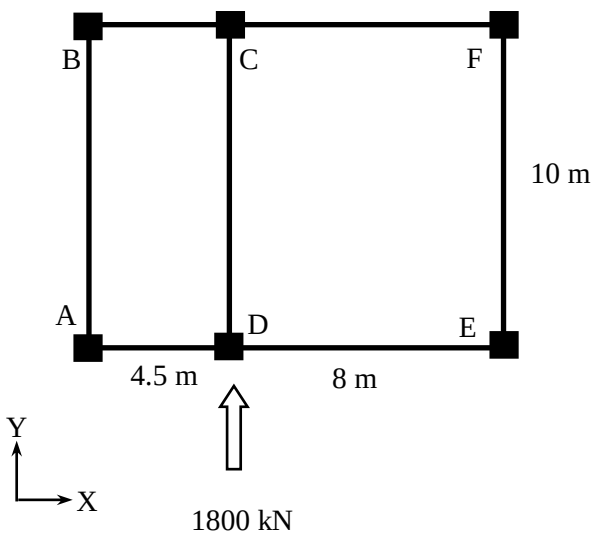

Figure 1

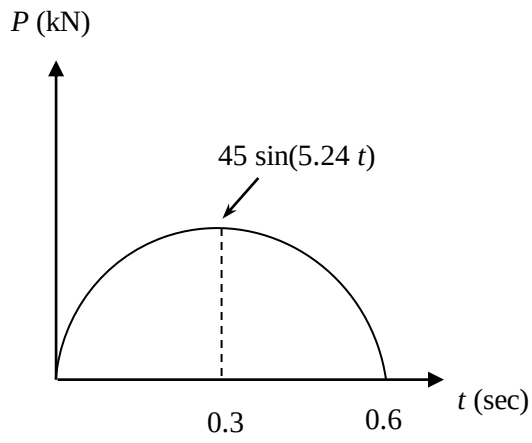

Figure 3