Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

ME – SEMESTER II (NEW) – • EXAMINATION – SUMMER 2016

Subject Code: 2722010 **Date: 25/05/2016**

Subject Name: Structural Dynamics and Earthquake Engineering

Time:10:30 am to 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. **Use of IS: 456, IS: 1893, IS: 4326 and IS: 13920 is permitted in exam hall, provided they do not contain anything other than the printed matter inside.**

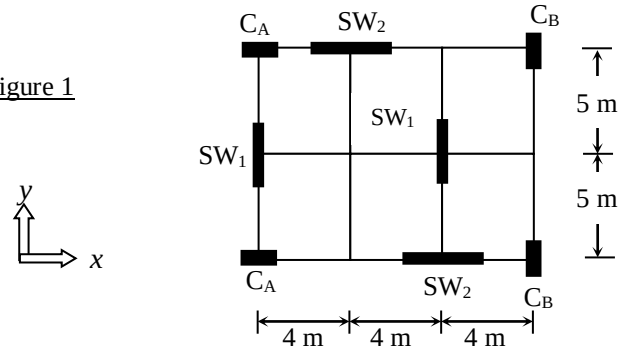
Q.1 **(a)** Explain: Earthquake Resistant Design philosophy. **06**

(b) Explain with sketches: Role of shear walls in seismic performance of buildings. **08**

Q.2 **(a)** A fixed beam of 5 m span carries a weight of 500 kN at the centre of span. The width of beam is 300 mm and depth is 350 mm. Calculate the natural frequency and time period of the system. Neglect the self weight of beam and consider modulus of elasticity as 200 Gpa. **06**

(b) Figure 1 shows the structural plan of building (storey height = 3.5 m) with column sizes, C_A = 450 x 300 mm, C_B = 300 x 450 mm, shear wall SW_1 = 150 x 1500 mm and SW_2 = 150 x 2000 mm. Calculate the centre of stiffness. Consider E = 25000 N/mm^2. **08**

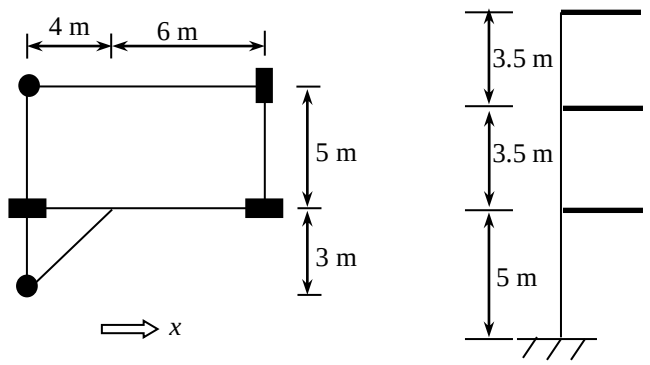
Figure 1



OR

(b) Figure 2 shows the Plan & vertical c/s of building. Determine whether the building has vertical stiffness irregularity or not considering the lateral force along '*x*' direction. Consider circular columns are of size 300 mm diameter and rectangular of size 300 mm x 460 mm as per orientation. Consider storey height = 3.5 m and E = 25000 N/mm^2. **08**

Figure 2



Q.3 Figure 3 shows the layout of a typical floor of a 10 storey building. Consider the following data: **14**

- Typical floor height = 3.6 m (slab top to slab top)
- Slab thickness = 120 mm
- Floor finish = 1 kN/m^2
- Live load = 4 kN/m^2
- All beams of 230 mm x 420 mm (including slab)
- Columns, C_A = 400 mm diameter, C_B = 600 mm x 300 mm
- Shear walls, SW_1 = 150 mm x 1300 mm, SW_2 = 150 mm thick
- 230 mm thick full height brick masonry wall on outer periphery of building.

Calculate the size of shear wall SW_2, so that centre of stiffness lies on grid – B. Also calculate the seismic weight at any typical floor. Consider E = 25000 N/mm^2.

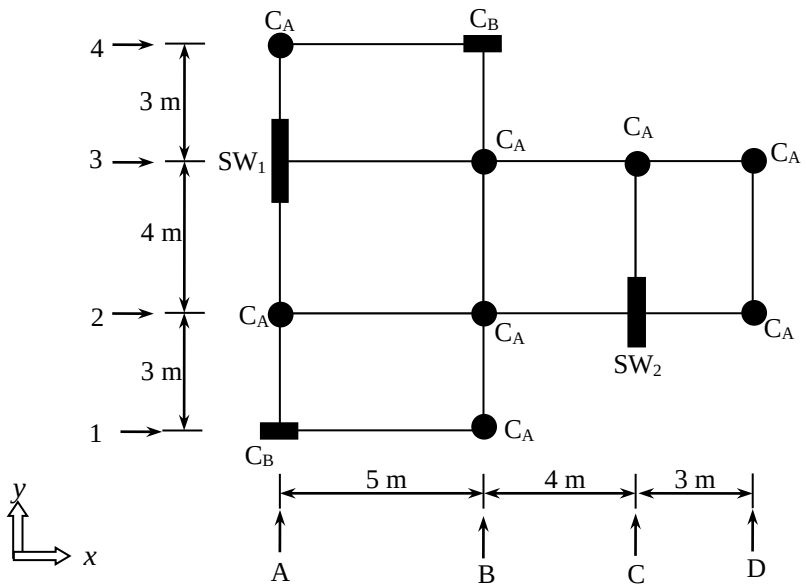


Figure 3

OR

Q.3 (a) What is the importance of ductile detailing? Discuss the important criteria to be considered for ductile detailing of beams and columns as per IS:13920. **06**

(b) Figure 4 shows the plan of single storey building with four shear walls. Consider the stiffness of shear wall about stronger axis as ‘9k’ and stiffness of about weaker axis as ‘k’. Calculate the joint forces on each frame considering the storey shear of 100 kN along earthquake in *x*-direction. **08**

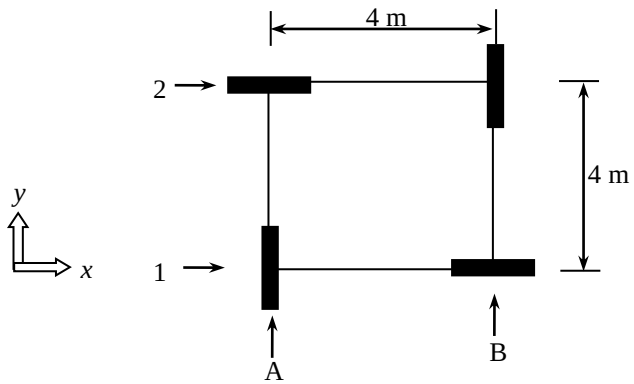


Figure 4

Q.4 A Three Storied building has lumped floor weights from bottom to top as 30 kN, 40 kN & 20 kN with storey stiffness of 50,000 N/m, 35,000 N/m & 20,000 N/m respectively. From the free vibration analysis the natural frequencies and corresponding mode shape coefficients are obtained as follows: **14**

ω_1 = 1.674 rad/sec, ω_2 = 3.913 rad/sec and ω_3 = 5.827 rad/sec

$\{\phi_1\} = \{\phi_{11}, \phi_{21}, \phi_{31}\} = \{0.33, 0.72, 1.0\}$

$\{\phi_2\} = \{\phi_{12}, \phi_{22}, \phi_{32}\} = \{-0.47, -0.53, 1.0\}$
$\{\phi_3\} = \{\phi_{13}, \phi_{23}, \phi_{33}\} = \{4.97, -2.4, 1.0\}$

Consider the building as ordinary residential building with Ordinary RC moment-resisting frame (OMRF) proposed on medium soil in Zone III. Calculate the Design Lateral forces at each floor in each mode. Also Calculate Storey shear force considering participation of all modes. Use SRSS or CQC method to get peak response quantities.

OR

Q.4 **(a)** What is Duhamel's Integral? Explain the use and importance of Duhamel's Integral. **06**

(b) An idealized SDOF system consists of a RCC water tank shaft of 4 m outer diameter & 120 mm wall thickness, which supports a container of 2800 kN weight at its top. The effective height of column shaft is 15 m. The damper offers the resistance of 25 kN at the velocity of 3 m/sec. Calculate the damping ratio and state whether the system is under damped, over damped or critically damped. Also calculate the damped frequency. Consider E = 25000 N/mm^2. (Assume $K = 3EI/L^3$) **08**

Q.5 **(a)** Explain various types of energy dissipation devices and their importance. **07**

(b) Discuss with sketches about the necessary seismic provisions which are to be considered for the G+1 storied earthquake resistant masonry buildings as per IS:4326. **07**

OR

Q.5 **(a)** What is Response Spectrum? Explain the importance of combined D-V-A Spectrum. **07**

(b) A platform of weight 1800 kN is being supported by four equal columns which are clamped to the foundation. Experimentally, it has been computed that a static force 5 kN applied horizontally, to the platform produces a displacement of 2.5 mm. It is estimated that the damping in the structure is of the order of 5% of critical damping. Calculate Undamped natural frequency, Damping coefficient, No. of cycles and time required for amplitude of motion to be reduced from an initial value of 2.5 mm to 0.25 mm **07**

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