Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–VII(NEW) • EXAMINATION – WINTER 2016

Subject Code:2170612 Date:18/11/2016

Subject Name:Earthquake Engineering(Departmental Elective - II)

Time:10.30 AM to 1.00 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, IS: 13920 and SP: 16 is permitted in exam hall, provided that they do not contain anything other than the printed matter inside.**

Q.1 **(a)** Figure 1 shows the layout of a typical floor of a 10 storied building. Consider the following data: **07**

- 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, only on outer periphery of building.
- Modulus of elasticity = 25000 N/mm^2.

Calculate the size of shear wall SW_2, so that centre of stiffness lies on grid – B (i.e. x_{cs} = 5 m).

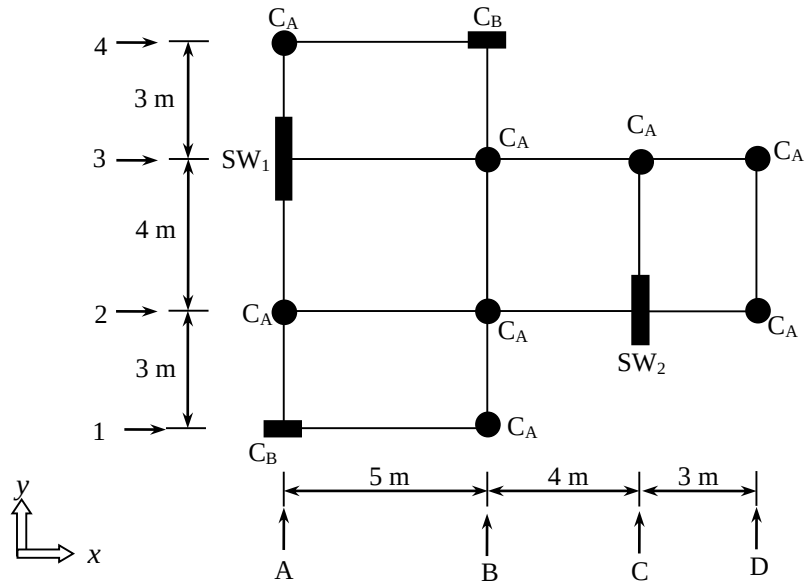

Figure 1

(b) Calculate the seismic weight at any typical floor considering the data given in Q.1 (a). **07**

Q.2 **(a)** Figure 2 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. **07**

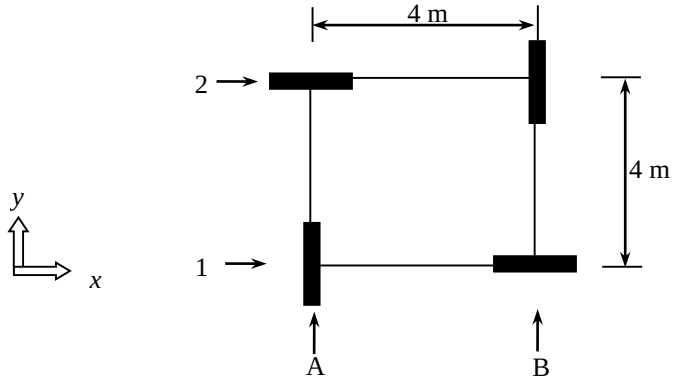

Figure 2

(b) Calculate the centre of mass at any typical floor considering the data given in Q.1 (a). (Neglect the self weight and space occupied by columns and shear walls) **07**

OR

(b) Figure 3 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. All beams of size = 230 mm x 460 mm, slab thickness = 100 mm, LL at all levels = 3 kN/m^2 and FF = 1 kN/m^2, modulus of elasticity = 25000 N/mm^2. **07**

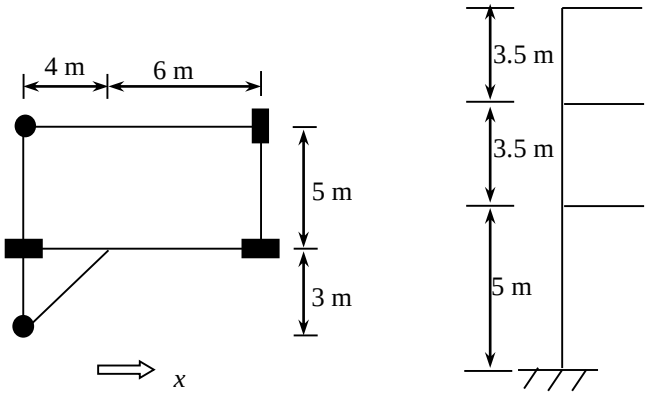

Figure 3

Q.3 **(a)** Define: Magnitude, Intensity, Hypocenter, Isoseismals, Seismogram, Rayleigh waves, Tectonic plate. **07**

(b) Explain and sketch the provisions of ductile detailing of reinforcement at various locations in beams. **07**

OR

Q.3 **(a)** Explain the capacity design concept of ductile detailing using chain analogy and state its application in beam design. **07**

(b) Explain: Seismic design philosophy and four important virtues (parameters) of earthquake resistant design of structures. **07**

Q.4 **(a)** A forced undamped vibration system consists of simply supported beam of 6 m span which supports a machine of weight 980 kN placed at the centre of the span. The machine exerts the harmonic force of 15 kN with the forcing frequency of 10 rad/sec. Calculate the maximum dynamic amplitude of vibration for the system by considering width of beam as 0.5 m and depth as 0.1 m. Consider E = 2 x 10^5 MPa. Neglect the self-weight of beam. **07**

(b) A two storied building has lumped floor weights from bottom to top as 95000 N & 78500 N with storey stiffness of 5 x 10^5 N/m and 4 x 10^5 N/m respectively. Perform the free vibration analysis & determine natural frequencies and corresponding mode shape coefficients. Also sketch the mode shapes. **07**

OR

Q.4 **(a)** Develop the equation of motion for free damped single degree-of-freedom system and derive the general solution of displacement response. **07**

(b) 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. **07**

From the free vibration analysis the natural frequencies and corresponding mode shape coefficients are obtained as follows:

$\omega_1 = 1.674$ rad/sec, $\omega_2 = 3.913$ rad/sec and $\omega_3 = 5.827$ 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 at Zone III.

Calculate the design lateral forces at each floor in each mode. Also calculate storey shear force considering participation of all modes using SRSS method.

Q.5 **(a)** An idealized SDOF system consists of a RCC water tank shaft of 4 m outer diameter & 120 mm wall thickness, which supports a container with lumped weight of 2800 kN 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. **07**

(b) Explain: (i) Types of structural controls. **07**
(ii) Soil liquefaction.

OR

Q.5 **14**

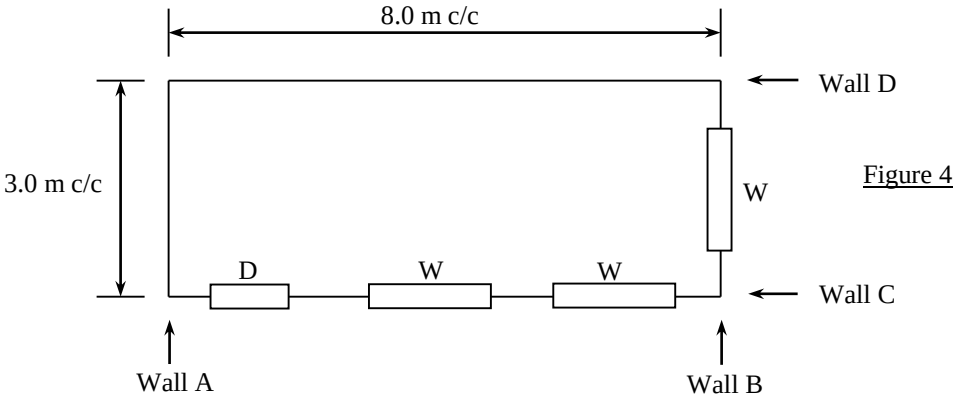

Figure 4

Figure 4 shows the plan of two storied brick masonry important building proposed at Zone III. Consider the thickness of wall A & B as 460 mm and of wall C & D as 340 mm. Decide the maximum size of windows for wall C considering width of door as 900 mm using IS: 4326 provisions. Also, enlist in detail with sketches, the necessary strengthening arrangements recommended for this building as per IS : 4326 provisions.

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