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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SECOND SEMESTER M.TECH DEGREE EXAMINATION, MAY 2016

CIVIL ENGINEERING

10CE6106 ANALYSIS AND DESIGN OF EARTHQUAKE RESISTANT STRUCTURES

Max. Marks: 60 Duration: 3 Hours

Part A (Modules I - II)

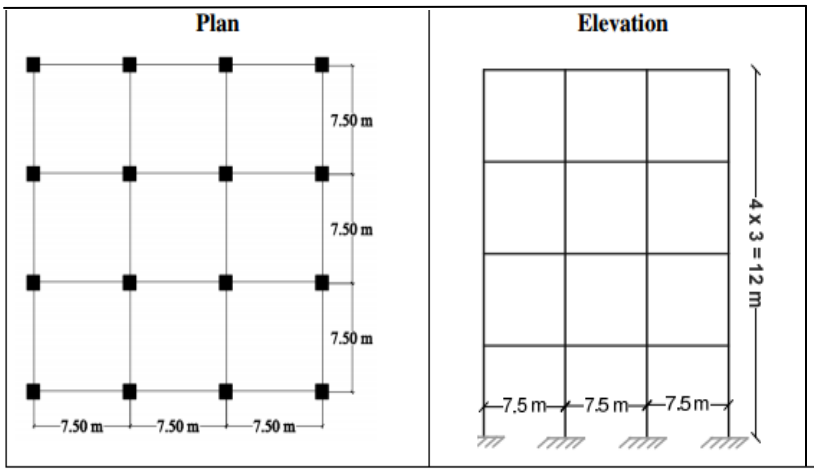
(Answer any two questions : 2 x 9 = 18 Marks)

1) a) What are the two measures of earthquake?

b) Name the two kinds of body waves and explain how they differ?

(5+4 marks)

2) Plan and elevation of a four-storey reinforced concrete office building is shown in Figure. The details of the building are as follows. Number of Storey = 4, Zone = III, Live Load = 3 kN/m^2, Columns = 450 x 450 mm, Beams = 250 x 400 mm, Thickness of Slab = 150 mm, Thickness of Wall = 120 mm, Importance factor = 1.0, Structure type = OMRF Building, Determine design seismic lateral load and storey shear force distribution by Equivalent Static Lateral force method.



(9 marks)

3a) How do human activities induce earthquakes?

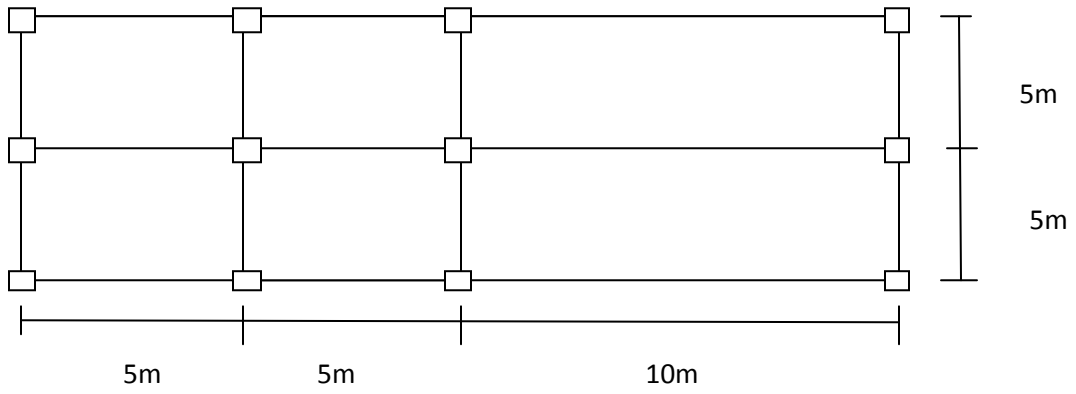
b) Explain the seismic design philosophy and guidelines for earthquake resistant structures?

(4+5 marks)

Part B (Modules III - IV)

(Answer any two questions : 2 x 9 = 18 Marks)

4 a) Locate the centre of stiffness for the plan of a simple one storey building as shown in figure. All the beams and columns have same cross sections.



b) Explain the concept of capacity design philosophy? (4+5 marks)

5 a) Explain the basic principles for design and detailing of flexural members as per IS 13920?

b) Explain the importance of ductility of structures with respect to its seismic performance?

(5+4 marks)

6) Explain the structural problems and remedial measures associated with following building configurations:

a) Soft storey frame

b) Re-entrant corners

c) Discontinuous shear wall

(3+3+3 marks)

Part C (Modules V & VI)

(Answer any two questions : 2 x 12 = 24 Marks)

7) A RCC beam of rectangular section has to carry a distributed live load of 20kN/m in addition to its own weight and a dead load of 25kN/m. The maximum bending moment and shear force due to earthquake are 60kNm and 40kN respectively. Centre to centre distance between supports is 6m. Design the beam using M20 grade concrete and Fe 415 steel. (12 marks)

8) Explain the methods of repair and rehabilitation of damaged structures? (12 marks)

9) Define shear walls? Describe the design procedure of shear wall?

(12 marks)

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SECOND SEMESTER M.TECH DEGREE EXAMINATION, APRIL 2017

CIVIL ENGINEERING

(Structural Engineering and Construction Management & Computer Aided Structural Engineering)

10CE6106 ANALYSIS AND DESIGN OF EARTHQUAKE RESISTANT STRUCTURES

Max. Marks: 60 Duration: 3 Hours

Instructions: Any data required may be suitably assumed and clearly indicated

Use of IS 1893(Part 1): 2002, IS 1893(Part 4):2005, IS13920: 1993, IS 456:2000 and SP16 is permitted

Part A (Modules I - II)

(Answer any two questions: 2 x 9 = 18 Marks)

1a) What is the significance of response reduction factor.

b) Discuss the main characteristics of seismic waves.

(4+5=9 marks)

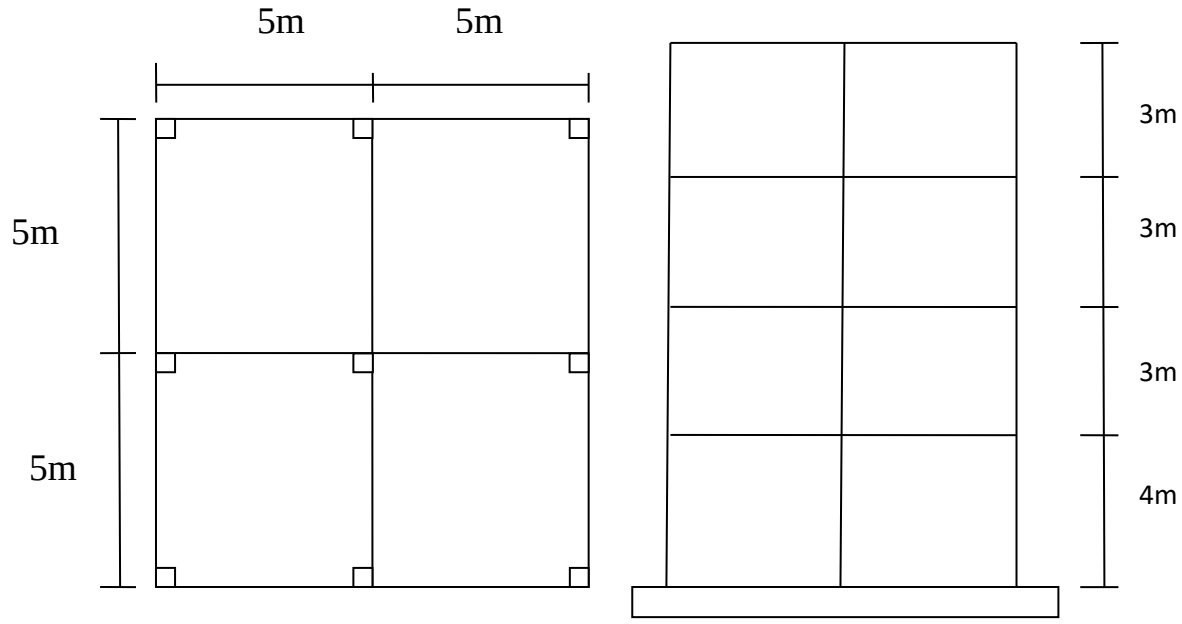
2a) Explain Plate Tectonics Theory of earthquakes.

b) Discuss briefly classification of earthquakes.

(5+4=9 marks)

3) Determine the design seismic forces for a symmetric building frame as shown in figure below. It is situated in zone IV and founded in Type II medium soil by static analysis. It has special moment resisting frames and all the frames are having infill with brick masonry. Take the lumped weight due to dead loads as 10 kN/m^2 for roof and 12kN/m^2 for floors ; live load is 1kN/ m^2 in roof and 4kN/m^2 in floors.

(9 marks)



PLAN ELEVATION

Part B (Modules III - IV)

(Answer any two questions: 2 x 9 = 18 Marks)

4) Explain the provisions for providing special confining reinforcement in rectangular columns with reference to IS 13920 with neat figure.

(9 marks)

5 a) Briefly describe the concepts of capacity based design.

b) How can we increase the ductility and energy dissipation capacity of a building.

(5+4=9 marks)

6 a) What is a soft storey building? How does it behave during earthquake?

b) What are the general features of an earthquake resistant building?

(5+4=9 marks)

Part C (Modules V & VI)

(Answer any two questions: 2 x 2 = 24 Marks)

7a) Describe the general requirements of shear wall with boundary elements.

b) Discuss the various rehabilitation techniques for RC buildings. (6+6=12 marks)

8 a) Explain briefly seismic evaluation of reinforced concrete structures.

b) Write short note on vulnerability reduction.

(7+5=12 marks)

9) Evaluate the earthquake forces on a reinforced concrete chimney located in seismic zone V and founded in raft on medium soft soil. Height of the chimney is 40m, outer diameter at base 3.5m, outer diameter at top 2.5m, thickness of shell 300mm throughout the height.

(12 marks)

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SECOND SEMESTER M.TECH. DEGREE EXAMINATION, APRIL 2017

CIVIL ENGINEERING

10CE6106: Analysis and Design of Earthquake Resistant Structures

Max. Marks : 60 Duration: 3 Hrs

Use of IS codes (IS 456,SP 16, IS 1893 part 1,4, IS 13920) are permitted

Part A

(Answer any two questions : 2 x 9 = 18 Marks)

1. Write a note on intensity of an earthquake. What are the different intensity scales? 9 Marks
2. Differentiate between static and dynamic analysis 9 Marks
3. A four-storey hospital building of height 12m (each storey 3m) is situated at Roorkee.The dead load(kN) and normal live load (kN) is lumped at respective floor and is given in the table . The soil below the foundation is assumed to be .hard rock. Determine the total base shear as per IS 1893 and distribute the base shear along the height of the building.

Floor level	DL + LL (kN)
1	3000
2	3000
3	3000
4 (roof)	2500

9 Marks

Part B

(Answer any two questions : 2 x 9 = 18 Marks)

4. How the horizontal layout affect the seismic response of a building ? 9 Marks
5. Write a note on capacity design concept 9 Marks
6. What are the codal provisions for the ductile detailing of RC column? 9 Marks

Part C

(Answer any two questions : 2 x 12 = 24 Marks)

7. Write a note on seismic dampers. 12 Marks
8. A RC chimney of height 28m is located in seismic zone 5.the outer diameter at the base and top are 3m and 1.8 m respectively. The thickness of the shell and lining is .3m and .1m respectively. Evaluate the earthquake forces on the chimney. Take $E=2x10^5$ ton/m^2

12 Marks

9. Design and detail a RC exterior column of size 300mm X 530 mm .subjected to the following loads.

   Axial load - 475.6 kN ; Moment - 203.3 kNm ;Shear - 77.8kN

   Bending moment acting on the adjoining beam - hogging moment – 240kNm , sagging moment – 139 kNm

   Use M20 concrete and Fe 415 steel. 12 Marks

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SECOND SEMESTER M.TECH. DEGREE EXAMINATION, APRIL 2018

CIVIL ENGINEERING

10CE6106 ANALYSIS AND DESIGN OF EARTHQUAKE RESISTANT STRUCTURES

Max. Marks : 60 Duration: 3 Hrs.

Use of IS 1893 Part 1, IS 1893 Part 4, IS 456:2000, SP16, IS 13920 are permitted

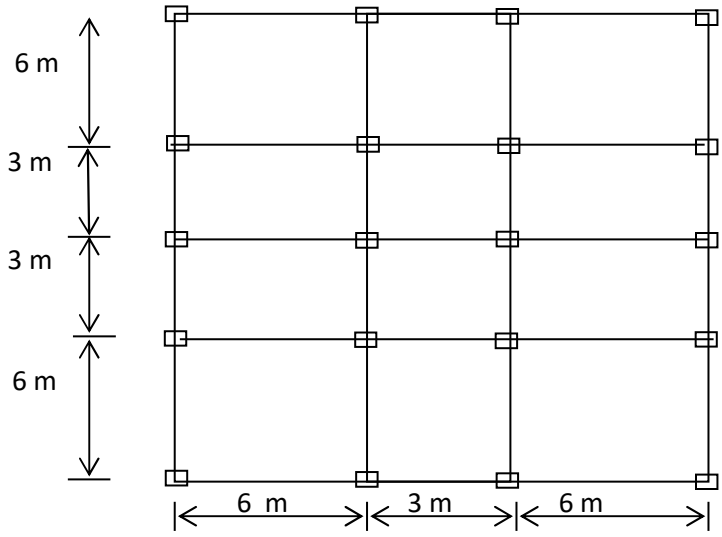
PART A (Module I-II)

(*Answer any **two** questions : 2 × 9 = 18 Marks*)

1. a) Explain the different scales for measuring earthquake magnitude. (5 marks)

   b) Discuss the main characteristics of different types of seismic waves. (4 marks)

2. Plan of a five storey school building located in Zone 5 is shown in Fig. 1. Dead load including self - weight is 5 kN/m^2 and live load is 4 kN/m^2 on each floor and 1.5 kN/m^2 on the roof. Determine the lateral forces and storey shears at different floor levels in both the orthogonal directions by equivalent static analysis.



(Fig. 1)

3. a) How is the frequency content of earthquake represented? (5 marks)

   b) Explain the working of a seismograph. (4 marks)

PART B (Module III-IV)

(*Answer any **two** questions : 2 × 9 = 18 Marks*)

4. What are the characteristics of a response spectrum? Explain the construction of the elastic design response spectrum.

5. Plan of a building having 4 identical shear walls, each 5m long and 200 mm thick is shown in Fig. 2. Determine the design lateral forces in shear walls if the storey height is 4 m and the seismic force on the building is 350 kN in either direction. Assume M 25 grade concrete.

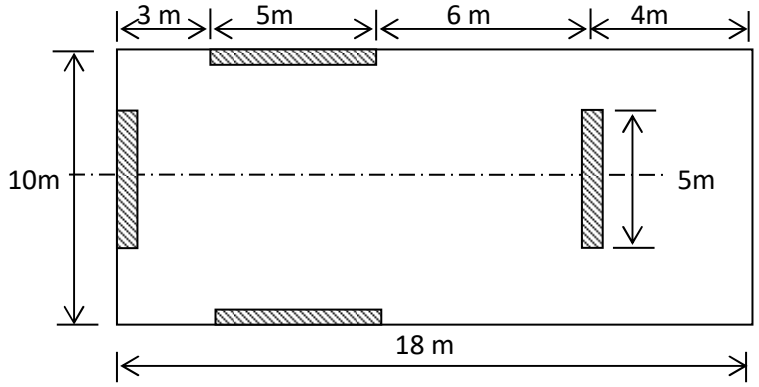


Fig. 2

6. Discuss the capacity design philosophy for earthquake resistant design of RC structures.

PART C (Module V-VI)

(*Answer any **two** questions : 2 × 12 = 24 Marks*)

7. a) Explain the procedure for design of shear reinforcement in beams using IS 13920. (5 marks)

b) A circular column 3.5 m. high, 300 mm diameter is reinforced with 8 bars of 20 mm dia. as main reinforcement and 10 mm dia. at 100 mm spacing. Assuming M 25 concrete, 40 mm clear cover and Fe 415 steel, design the special confining reinforcement. (7 marks)

8. Evaluate the forces on a RC chimney of height 30 m, outer diameter at the base 2.8 m and at top 2 m, shell thickness 25 cm, lining thickness 10 cm located on medium soil in Zone 5. E $=2\times10^7$ kN/m^2

9. Discuss the methods of rehabilitation of damaged RC elements.

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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SECOND SEMESTER M.TECH. DEGREE EXAMINATION, MAY 2019

CIVIL ENGINEERING

10CE6106: ANALYSIS AND DESIGN OF EARTHQUAKE RESISTANT STRUCTURES

Any missing data may be suitably assumed and stated

Use of IS 1893(Part 1), IS 1893(Part 4), IS13920, IS 456 and SP16 is permitted

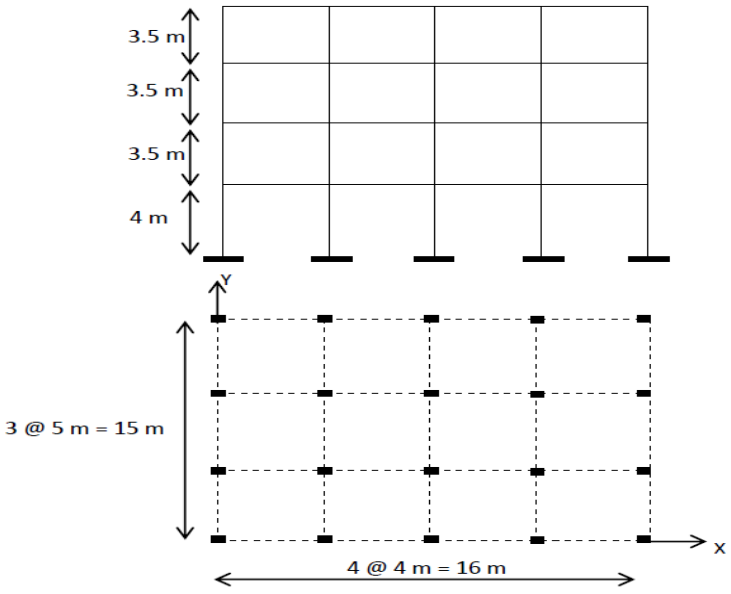
Max. Marks: 60 Duration: 3Hrs

Part A

(Answer any two questions: 2x9 = 18 Marks)

1. a) Explain Plate Tectonics Theory of earthquakes. 3 Marks
   b) Explain different type of plate margins. 6 Marks

2. Plan and elevation of a four-storey reinforced concrete office building is shown in Figure. The details of the building are as follows. Number of Storey = 4, Zone = V, Live Load = 4 kN/m^2, Dead Load = 12 kN/m^2 on floor and 10 kN/m^2 on roof. Structure type = SMRF Building, Soil type – medium, Determine design seismic lateral load and storey shear force distribution by Equivalent Static Lateral force method.



9 Marks

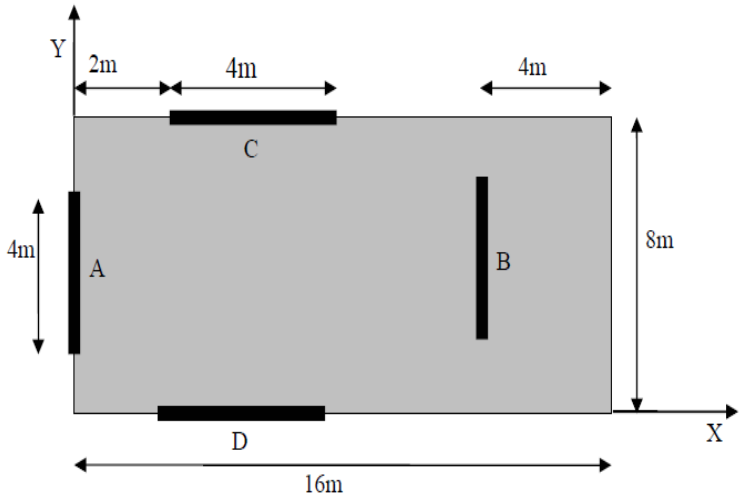
3. Explain the step by step procedure for the design of earthquake resistant structures as per,
   a) Equivalent static force analysis 4.5 Marks
   b) Dynamic analysis 4.5 Marks

Part B

(Answer any two questions:2x9 = 18 Marks)

4. Explain the building architectural consideration for effective seismic design. 9 Marks

5. Consider a simple one storey building having two shear walls in each direction. It has some gravity columns that are not shown. All four walls are M25 grade concrete, 200 mm thick and 4m long. Storey height is 4.5 m. Floor consist of cast insite reinforced concrete. Design shear force on building is 100 kN, beneath the direction. Compute design lateral force on different shear walls using torsion provision of IS1893 part I. Assume all wall are same and hence, it is of same lateral stiffness k.



9 Marks

6. Design special confining reinforcement for a rectangular column 600 x 500 mm. Grade of concrete – M20 and Fe 415 steel 9 Marks

Part C

(Answer any two questions: 2 x12 = 24 Marks)

7. Explain the methods of repair and rehabilitation of damaged structures? 12 Marks

8. Determine earthquake force for the RC chimney for following data
   Height – 30m
   Outer diameter – 3m at bottom and 2m at top
   Thickness of shell – 300mm
   Thickness of lining – 100mm
   Foundation – raft on hard soil
   Take zone IV and M30 concrete 12 Marks

9. a) Define shear walls and explain functions? 6 Marks
   b) What are the different modes of failure of shear wall? 6 Marks

Reg No.:_____ Name:_____

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M.Tech S2 (R,S) Exam July 2021

Reg. No…… Name:……..……

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SECOND SEMESTER M.TECH DEGREE EXAMINATION

CIVIL ENGINEERING

10CE6106: ANALYSIS AND DESIGN OF EARTHQUAKE RESISTANT STRUCTURES

Max. Marks : 60 Duration: 3 Hours

PART A (Modules I & II)

Answer any TWO full questions (2 x 9=18 Marks)

Note: Use of IS 1893(Part 1), IS 1893(Part 4), IS13920, IS 456 and SP16 is permitted.

1 **(a)** Differentiate between static and dynamic analysis for the determination of lateral forces? **(5 Marks)**

(b) What is the significance of response reduction factor? **(4 Marks)**

2 **(a)** A four-storey hospital building of height 12m (each storey 3m) is situated at Kannur. The dead load(kN) and normal live load (kN) is lumped at respective floor and is given in the table 1 . The soil below the foundation is assumed to be hard rock. Determine the total base shear as per IS 1893 and distribute the base shear along the height of the building. **(9 Marks)**

Table 1: floor loads

Floor level	DL + LL (kN)
1	2000
2	2000
3	2000
4(roof)	1500

3 **(a)** Explain Plate Tectonics Theory of earthquakes **(5 Marks)**

(b) Explain the different scales for measuring earthquake magnitude **(4 Marks)**

PART B (Modules III & IV)

Answer any TWO full questions (2 x 9=18 Marks)

4 **(a)** Write a note on capacity design concept for earthquake resistant design of RC structures? **(4 Marks)**

	(b)	Explain the building architectural consideration for effective seismic design?	**(5 Marks)**
5	**(a)**	Explain the provisions for providing special confining reinforcement in rectangular columns with reference to IS 13920 with neat figure?	**(9 Marks)**
6	**(a)**	Explain the construction of the elastic design response spectrum?	**(4 Marks)**
	(b)	Explain the Computation of design lateral force using torsion provision of IS1893 part I for a building with three shear walls ?	**(5 Marks)**

PART C (Modules V & VI)

Answer any TWO full questions (2 x 12=24 Marks)

7	**(a)**	A fixed-ended RC beam of rectangular section has to carry a distributed live load of 30 kN/m in addition to its own weight and a dead load of 20 kN/m. The maximum bending moment and shear force due to the earthquake are 50 kNm and 40 kN respectively. Centre-to-centre distance between supports is 7 m. Design the beam using M-25 grade concrete and Fe-415 steel	**(12 Marks)**
8	**(a)**	Discuss the various rehabilitation techniques for RC buildings?	**(6 Marks)**
	(b)	What is the purpose of providing a shear wall?	**(3 Marks)**
	(c)	Explain the procedure for the design of RC columns using IS 13920	**(3 Marks)**
9	**(a)**	Explain briefly seismic evaluation of reinforced concrete structures?	**(6 Marks)**
	(b)	Design the reinforcement for a column of size 450 mm × 450 mm, subjected to the following forces. The column has an unsupported length of 3.0 m and is braced against side sway in both directions. The factored load and factored moment are 2820 kN and 228 kNm. Use M-25 grade concrete and Fe-415 steel	**(6 Marks)**
