SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF CIVIL ENGINEERING

QUESTION BANK

III SEMESTER

1917301–EARTHQUAKE ANALYSIS AND DESIGN OF STRUCTURES

M.E. STRUCTURAL ENGINEERING

Regulations – 2019

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SUBJECT: 1917301–EARTHQUAKE ANALYSIS AND DESIGN OF STRUCTURES

SEM / YEAR: III/II

UNIT I – EARTHQUAKE GROUND MOTION			
Engineering Seismology (Definitions, Introduction to Seismic hazard, Earthquake Phenomenon), Seismotectonics and Seismic Zoning of India, Earthquake Monitoring and Seismic Instrumentation, Characteristics of Strong Earthquake Motion, Estimation of Earthquake Parameters.			
PART – A			
Q.No	**Questions**	**BT Level**	**Competence**
1.	Write about folds in tectonics	BT-1	Remember
2.	Define seismology.	BT-1	Remember
3.	How will you develop an isoseismal map?	BT-1	Remember
4.	Write the major types of plates in engineering seismology.	BT-1	Remember
5.	Describe transform boundaries.	BT-1	Remember
6.	List the types of faults.	BT-1	Remember
7.	List out some disastrous earthquakes occurred in past history in India.	BT-1	Remember
8.	What are the earthquake parameters?	BT-1	Remember
9.	Enlist the seismic instruments.	BT-1	Remember
10.	What is seismo tectonics?	BT-1	Remember
11.	Enumerate about zoning of earthquake	BT-2	Understand
12.	Compare convergent and divergent boundaries.	BT-2	Understand
13.	Outline about body waves and surface waves.	BT-2	Understand
14.	Compare and contrast focus and epicenter.	BT-2	Understand
15.	Describe about the characteristics of earthquake.	BT-2	Understand
16.	Differentiate between P-waves and S-waves.	BT-2	Understand
17.	Contrast Mercalli intensity scale and Richter scale.	BT-2	Understand
18.	Generalize the term soil amplification.	BT-2	Understand

19.	Generalize the term seismogram.	BT-2	Understand
20.	Explain elastic rebound theory.	BT-2	Understand
21.	Illustrate about seismic hazards	BT-3	Application
22.	Illustrate on microzonation.	BT-3	Application
23.	Illustrate the factors affecting ground motion.	BT-3	Application
24.	Compose on isoseismal line.	BT-3	Application
25.	Compose about seismograph.	BT-3	Application

PART - B

1.	Name the major plates of the earth and elaborate any three in detail.	BT-3	Application
2.	i. Define focus and epicenter of an earthquake. (5) ii. Name the kinds of body waves and explain it with neat Sketch. (8)	BT-3	Application
3.	Define Ritcher scale and MMI scale and explain it in detail.	BT-3	Application
4.	Describe plate tectonic theory with a neat sketch.	BT-3	Application
5.	Explain in detail about Elastic rebound theory.	BT-3	Application
6.	Define faults. Also show how they are associated with earthquake.	BT-4	Analyzing
7.	Classify seismic zoning of India as per IS 1893:2002.	BT-4	Analyzing
8.	Explain past earthquake occurrence in India.	BT-4	Analyzing
9.	Write in detail about strong earthquake motion.	BT-4	Analyzing
10.	i. Differentiate magnitude and intensity. (7) ii. How will you measure magnitude and intensity? Explain the methods. (6)	BT-4	Analyzing
11.	Discuss about the classification of earthquake.	BT-4	Analyzing
12.	Illustrate the principle of seismograph and seismogram with sketch.	BT-4	Analyzing
13.	How seismic waves are induced? Explain the different types of seismic waves.	BT-4	Analyzing
14.	Explain about seismic instrumentation and monitoring.	BT-3	Application
15.	Explain the types of geological faults.	BT-3	Application
16.	List out the causes of earthquake and explain it briefly.	BT-3	Application

17.	List out the design principles of earthquake resistant structure as per IS 1893-2002.	BT-3	Application

PART - C

1.	Explain in detail about the recent advancements in instrument of earthquake.	BT-5	Evaluating
2.	Discuss case study on any one of the earthquake that has occurred in the Tamilnadu.	BT-5	Evaluating
3.	Explain the recent zone classification in India.	BT-5	Evaluating
4.	Prepare a case study about ocean observation system regarding earthquake	BT-5	Evaluating
5.	Discuss about the internal structure of the earth.	BT-5	Evaluating

UNIT II - EFFECTS OF EARTHQUAKE ON STRUCTURES

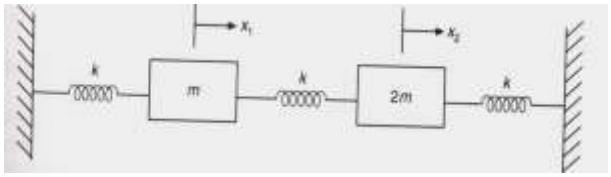
Dynamics of Structures (SDOFS&MDOFS), Response Spectra - Evaluation of Earthquake Forces as per codal provisions - Effect of Earthquake on Masonry and RCC Structures - Lessons Learnt From Past Earthquakes

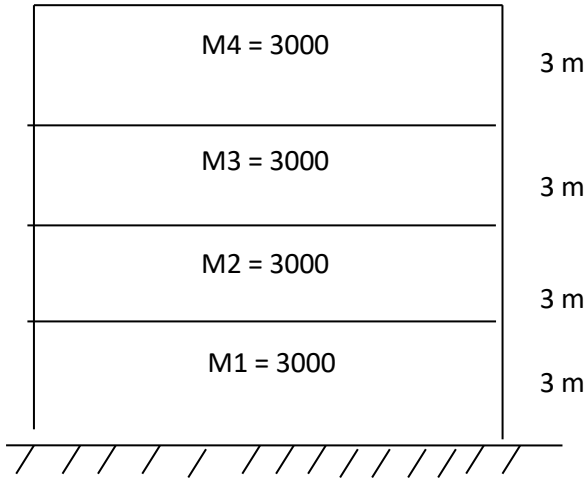
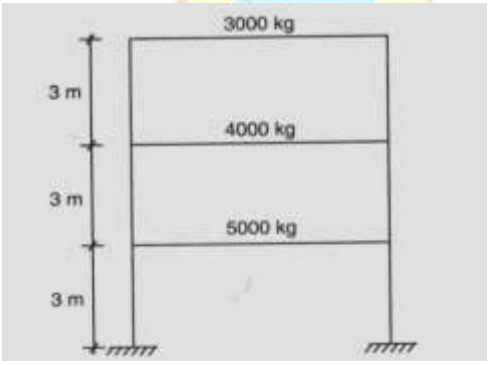
PART – A

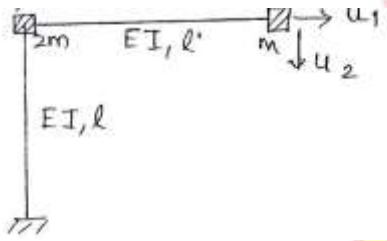
Q.No	Questions	BT Level	Competence
1.	Outline about codal provisions regarding earthquake.	BT-1	Remember
2.	Formulate simple Harmonic motion	BT-1	Remember
3.	Define Degrees of freedom	BT-1	Remember
4.	Opinion about transient vibration and earthquake excitation.	BT-1	Remember
5.	Brief fundamental frequency and fundamental mode.	BT-1	Remember
6.	Define the term base shear.	BT-1	Remember
7.	Define response spectra.	BT-1	Remember
8.	Define logarithmic decrement method.	BT-1	Remember
9.	Compose the equation of motion for a damped two degree of freedom system.	BT-2	Understand
10.	Compose the characteristic equation for free vibration of un-damped system.	BT-2	Understand
11.	Write about dynamics of structures.	BT-2	Understand
12.	Enlist the different types of degrees of freedom	BT-2	Understand

13.	Explain about slenderness ratio	BT-2	Understand
14.	Compare statics and dynamics	BT-2	Understand
15.	Outline D-Alembert's principle.	BT-2	Understand
16.	Compare static and dynamic loading.	BT-2	Understand
17.	Discuss the types of damping.	BT-2	Understand
18.	Explain the term storey drift.	BT-2	Understand
19.	A harmonic motion has a time period of 0.2s and amplitude of 0.4cm. Solve for the maximum velocity and acceleration.	BT-3	Application
20.	Illustrate a note on the lessons learnt from past earthquake.	BT-3	Application
21.	Analyse horizontal and vertical seismic coefficient.	BT-3	Application
22.	Explain two degrees of freedom system.	BT-3	Application
23.	Investigate about the major damages that would occur in the RC structures during earthquake.	BT-3	Application
24.	Justify, howyou will evaluate the distribution of design base shear along the height of the building.	BT-3	Application
25.	A cantilever beam 3m long supports a mass of 500kg at its upper end. Evaluate the natural period and natural frequency.	BT-3	Application

PART– B

1.	Describe and elaborate D'Alemberts Principle.	BT-4	Analyse
2.	Find the natural frequency and mode of vibration for the system shown. 	BT-4	Analyse
3.	Write the plan configuration problems that affect the performance of RC buildings during earthquake.	BT-4	Analyse
4.	A four storey reinforced concrete frame building as shown in fig: is situated at Roorkee. The height between the floors is 3 m and total height of building is 12 m. The dead load and live load is lumped at respective floor. The soil below the foundation is assumed to be hard rock. Assume building is intended to be used as a hospital. Findthe total base shear as per IS1893 (PART1): 2002. Distribute the base shear along the height of the building.	BT-4	Analyse

			
5.	Explain briefly the effect of earthquake on different types of structures.	BT-3	Application
6.	Discuss the mathematical modeling of an SDOF system.	BT-3	Application
7.	Discuss about the vertical irregularities that affect the performance of RC buildings during earthquake.	BT-3	Application
8.	Construct the step by step procedure for seismic analysis of RC buildings as per IS 1893:2002.	BT-3	Application
9.	Solve for the natural frequency and mode shape for the MDOF system. EI = 4.5 x 10^6 N-m^2 for all columns. 	BT-4	Analyse
10.	Examine the equation for multi degree of freedom for a two-storey shear building.	BT-3	Application
11.	A three storied symmetrical RC school building situated at Bhuj with following data: Plan dimension : 7 m Storey height : 3.5 m Total weight of beams in a storey : 130 kN Total weight of slabs in a storey : 250 kN Total weight of columns in a storey : 50 kN Total weight of walls in a storey : 530 kN Live load : 130 kN	BT-3	Application

	Weight of terrace floor : 655 kN The structure is resting on hard rock. Solve for the total base shear and lateral loads at each floor level for 5% of damping using seismic coefficient method.		
12.	A mass of 2 kg is suspended by a spring having a stiffness at 700 N/m. The mass is displaced downward from its equilibrium position by a distance of 0.02 m. Analyse the equation of motion, normal frequency, the response of the system and total energy.	BT-3	Application
13.	A damper offers resistance 0.08 N at a constant velocity 0.06m/s, the damper is used with a spring of stiffness equal to 12 N/m. Analyse the damping ratio and frequency of the system when the mass of the system is 0.3 kg.	BT-3	Application
14.	Evaluate the natural frequencies and mode of vibration of the given system. 	BT-4	Analyse
15.	A mass of 200 kN is suspended by a spring having stiffness at 0.7 kN/m. The mass is displaced downward from its equilibrium position by a distance of 0.02 m. Analyse the equation of motion, normal frequency, the response of the system and total energy.	BT-4	Analyse
16.	Describe the solution of equation of motion.	BT-3	Application
17.	Derive the equation of motion of a two degree of freedom system for free vibration.	BT-3	Application
18.	Determine the natural frequency and mode shapes of the following: The storey masses are M1=5, M2=4, M3=3 and storey stiffness are k1= k2= k3=2.	BT-4	Analyse

PART - C

1.	Explain the lesson learnt from past earthquake history	BT-5	Evaluating
2.	Predict the natural frequency and mode shapes of a MDOF	BT-4	Analyse

	system. The mass and the stiffness matrix of a MDOF system is given by $[M]=m\begin{bmatrix}1&0&0\\0&1&0\\0&0&2\end{bmatrix}, [K]=K\begin{bmatrix}2&-1&0\\-1&3&-2\\0&-2&2\end{bmatrix}.$		
3.	Write a step by step procedure to analyze a frame by equivalent static lateral load method.	BT-4	Analyse
4.	A special reinforced concrete moment resisting frame building with infill panels is situated in Delhi. The height and base dimension is 12m and 24m. Evaluate the design, horizontal seismic coefficient and vertical seismic coefficient for a damping ratio of 2 %.	BT-4	Analyse
5.	Define and discuss the following: I.Critical damping II.Coulomb damping III.Damped circular frequency	BT-3	Application

UNIT III - EARTHQUAKE RESISTANT DESIGN OF MASONRY STRUCTURES

Structural Systems - Types of Buildings - Causes of damage - Planning Considerations - Philosophy and Principle of Earthquake Resistant Design - Guidelines for Earthquake Resistant Design - Earthquake Resistant Masonry Buildings - Design consideration – Guidelines.

PART – A

Q.No	Questions	BT Level	Competence
1.	Write the design consideration for Earthquake resistant design.	BT-1	Remember
2.	Define diaphragm discontinuity.	BT-1	Remember
3.	Write about flexible diaphragm.	BT-1	Remember
4.	Define rigid diaphragm.	BT-1	Remember
5.	What is impounding of buildings?	BT-1	Remember
6.	Define diaphragm discontinuity.	BT-1	Remember
7.	Explain the concept of floating column.	BT-1	Remember

8.	What kind of damage occurs in staircase due to earthquake?	BT-1	Remember
9.	List out any four important data about Jabalpur earthquake.	BT-1	Remember
10.	Explain about the bands.	BT-2	Understand
11.	Outline the role of lintel bands in masonry buildings.	BT-2	Understand
12.	Compare flexible and rigid diaphragm.	BT-2	Understand
13.	Brief about Killari earthquake.	BT-2	Understand
14.	Outline the basis for the categories of masonry buildings as per IS 4326? Name them.	BT-2	Understand
15.	Write about principle of earthquake resistant design	BT-2	Understand
16.	Explain the importance of orientation of building in earthquake resistant design	BT-2	Understand
17.	Illustrate strengthening of masonry wall.	BT-3	Application
18.	Does grouting increase the earthquake resistance capacity? Justify your answer.	BT-3	Application
19.	Justify how to calculate the base shear in masonry buildings?	BT-3	Application
20.	Enumerate the importance of slenderness ratio in masonry column	BT-3	Application
21.	Analyse the stress strain curve for brickwork in compression.	BT-3	Application
22.	Justify, what will happen if the rigidity modulus affects the masonry structure.	BT-3	Application
23.	Prioritize structural and non-structural damages in masonry building.	BT-3	Application
24.	Compose the formula for modal mass.	BT-3	Application
25.	Compose the principle for the design of infill walls.	BT-3	Application

PART - B

1.	Explain the effect of slenderness ratio in masonry wall	BT-3	Application
2.	Classify the different types of masonry buildings according to IS 4326:1993	BT-3	Application
3.	Explain the behaviour of unreinforced masonry walls.	BT-3	Application
4.	Compare and contrast the behaviour of reinforced and unreinforced masonry walls.	BT-3	Application
5.	Brief about the behaviour of infill walls.	BT-3	Application
6.	How to improve the seismic capacity of masonry building?	BT-4	Analyse
7.	Write the various factors in seismic analysis and explain in detail.	BT-4	Analyse
8.	Explain in detail about seismic design spectrum.	BT-4	Analyse

9.	Describe the performance of masonry buildings during earthquake.	BT-3	Application
10.	List the methods for strengthening of masonry buildings	BT-3	Application
11.	Write the effects of earthquake on prestressed and steel buildings when compared to masonry buildings.	BT-3	Application
12.	Explain about the types of construction, types of damages and non damages in Bihar -Nepal Earthquake in masonry buildings	BT-4	Analyse
13.	Examine the plan configuration problems that affect the performance of masonry buildings during earthquake.	BT-3	Application
14.	Analyze the limitations of equivalent lateral force and response spectrum analysis procedures.	BT-3	Application
15.	Explain the damages in Masonry buildings.	BT-3	Application
16.	Explain the strengthening methods in detail with neat sketches.	BT-3	Application
17.	Classify the damages and non-damages occurred in masonry buildings during an earthquake with examples.	BT-3	Application

PART - C

1.	Write the earthquake resistant design procedure of a masonry building	BT-3	Application
2.	Distinguish between rigid and flexible diaphragm with neat sketches	BT-3	Application
3.	Prepare a case study on effects of earthquake on masonry buildings due to Bhuj earthquake.	BT-3	Application
4.	Study the damages of various Indian earthquake on buildings and give suggestions to improve the performance.	BT-3	Application
5.	Write down the various earthquake resistant features that can be introduced in masonry buildings.	BT-3	Application

UNIT IV - EARTHQUAKE RESISTANT DESIGN OF RC STRUCTURES

Earthquake Resistant Design of R.C.C. Buildings - Material properties - Lateral load analysis – Capacity based Design and detailing – Rigid Frames – Shear walls.

PART – A

Q.No	Questions	BT Level	Competence
1.	List the different types of irregularities.	BT-1	Remember

2.	Define ductility.	BT-1	Remember
3.	List the factors to be considered for design of a tall building.	BT-1	Remember
4.	Show the failure mechanism of unfilled frame.	BT-1	Remember
5.	Define modal participation factor.	BT-1	Remember
6.	Give the different types of shear wall	BT-1	Remember
7.	Define irregularities.	BT-1	Remember
8.	Enlist the references IS codes in earthquake resistant design.	BT-1	Remember
9.	Explain assessment of ductility.	BT-1	Remember
10.	What do you infer from capacity based design?	BT-2	Understand
11.	Differentiate frame and shear wall.	BT-2	Understand
12.	How mass irregularities differ from plane irregularities?	BT-2	Understand
13.	Distinguish between flexure beam model and shear beam model.	BT-2	Understand
14.	Examine the factors affecting ductility.	BT-2	Understand
15.	Compare RCC & Masonry earthquake resistant design.	BT-2	Understand
16.	Summarize the principle base shear.	BT-2	Understand
17.	Explain assessment of ductility.	BT-2	Understand
18.	Write the design steps of core wall.	BT-2	Understand
19.	Elaborate the detailed report on material properties of earthquake resistant design	BT-3	Application
20.	Explain strong column and weak beam	BT-3	Application
21.	Illustrate the vertical distribution of base shear.	BT-3	Application
22.	Derive the expression for base shear.	BT-3	Application
23.	Analyze shear beam model.	BT-3	Application
24.	Formulate the expression for time period as per codal provision IS 1893.	BT-3	Application
25.	Assess the shear wall to resist lateral load.	BT-3	Application

PART - B

1.	Describe how core wall resists shear in high rise RC building.	BT-3	Application
2.	List the step by step procedure for capacity based design of RC buildings.	BT-3	Application
3.	Describe the construction of floating box.	BT-3	Application

4.	Summarize the concept of rigid diaphragm action.	BT-3	Application
5.	Discuss briefly about the analysis of infilled frames.	BT-3	Application
6.	Examine the philosophy of earthquake resistant design of RC buildings.	BT-3	Application
7.	Design a rectangular beam for 8m span to support a DL of 10kN/m and a LL of 12kNm inclusive of its own weight. Moment due to earthquake load is 1000kNm and shear force is 80kN. Use M20 grade concrete and Fe415 steel.	BT-4	Analyse
8.	Explain the principles of earthquake resistant design of RC members.	BT-3	Application
9.	Evaluate the best strengthening techniques involved in RC building.	BT-4	Analyse
10.	Brief the step by step procedure to analyze a frame by equivalent static lateral load method.	BT-4	Analyse
11.	A four storey reinforced concrete frame building is situated at Roorkee. The height between the floors is 3 m and total height of building is 12 m. The dead load and normal live load is lumped at respective floor. The soil below the foundation is assumed to be hard rock. Assume building is intended to be used as a hospital. Determine the total base shear as per IS 1893 (Part 1):2002 and compare with the earlier IS: 1893 codes. Formulate the base shear along the height of the building.	BT-4	Analyse
12.	Explain the different types of shear wall with neat sketch.	BT-3	Application
13.	Design the exterior column of a multistorey building with size 400x500mm, axial load from analysis is 601.9 kN and moment from analysis is 176.6 kNm ,elaborate the ductile detailing.	BT-4	Analyse
14.	Design a shear wall for 14 stored reinforced building with reinforced concrete building as per the design requirement of IS 13920.Assume relevant data if any needed.	BT-4	Analyse
15.	List out the codal provisions for architectural considerations and structural design considerations as per IS 4326:1993.	BT-4	Analyse
16.	Classify the different types of shear wall with neat sketches	BT-4	Analyse

17.	Describe the importance of ductility in earthquake resistant design.	BT-4	Analyse

PART - C

1.	Explain about the design procedure of shear wall in detail.	BT-3	Application
2.	Explain capacity based design and detailing for RC building with example.	BT-3	Application
3.	Examine types of shear wall and what do you prefer for high rise building? Explain it.	BT-3	Application
4.	Discuss a R.C.C building frame procedure as per IS 1893:2002.	BT-3	Application
5.	Why and where special confining reinforcement is required in an earthquake resistant building?	BT-3	Application

UNIT V - VIBRATION CONTROL TECHNIQUES

Vibration Control - Tuned Mass Dampers – Principles and application, Basic Concept of Seismic Base Isolation – various Systems- Case Studies.

PART – A

Q.No	Questions	BT Level	Competence
1.	Write the important structures where base isolator needed?	BT-1	Remember
2.	What do you mean by base isolation?	BT-1	Remember
3.	List out need for base isolation.	BT-1	Remember
4.	State the mechanism for base isolation.	BT-1	Remember
5.	Name the parts of a typical isolator.	BT-1	Remember
6.	Why base isolation is effective?	BT-1	Remember
7.	Write about isolation and its effectiveness.	BT-1	Remember
8.	Write about friction damper.	BT-1	Remember
9.	Give the principle of base isolation	BT-1	Remember
10.	Describe the response of base isolation in a structure.	BT-1	Remember
11.	Discuss about tuned mass dampers.	BT-2	Understand
12.	Explain the use of metallic dampers.	BT-2	Understand
13.	Illustrate the criteria to be met by building for effective base	BT-2	Understand

	isolation.		
14.	Draw the cross section of base isolator	BT-2	Understand
15.	Classify the type of dampers.	BT-2	Understand
16.	Examine viscous fluid dampers.	BT-2	Understand
17.	What do you understand about metallic dampers?	BT-3	Application
18.	Enlist the application of vibration control system	BT-3	Application
19.	How base isolators resist earthquake forces?	BT-3	Application
20.	Sketch the typical base isolator.	BT-3	Application
21.	Write about the important structures in which base isolation has to be installed.	BT-3	Application
22.	Show the types of base isolation system.	BT-3	Application
23.	Evaluate the performance of base isolation in India with example.	BT-3	Application
24.	Generalize the practical application of dampers.	BT-3	Application
25.	Elaborate the uses of tuned mass dampers	BT-3	Application

PART-B

1.	Describe in detail about the concept of base isolation.	BT-3	Application
2.	With a neat sketch, Quote the functions of tuned mass damper.	BT-3	Application
3.	Identity how viscous fluid dampers resist vibration.	BT-3	Application
4.	Write the new techniques in aseismic design.	BT-3	Application
5.	Discuss the elements and types of base isolation system with neat sketch.	BT-4	Analyse
6.	Describe the response of building to base isolation and Summarize the criteria that should be met for effective base isolation.	BT-4	Analyse
7.	Write detailed comment on seismic dampers.	BT-4	Analyse
8.	Distinguish between metallic dampers and friction dampers.	BT-3	Application
9.	Discuss a case study on installation of base isolators in Bhuj hospital, Gujarat.	BT-3	Application
10.	Explain the application of base isolation in different countries.	BT-3	Application
11.	Examine how vibration control techniques be applied for important structures? Give an example.	BT-3	Application

12.	List out the different types of seismic dampers.Explain each of them.	BT-3	Application
13.	Illustrate the use of dampers and base isolation in various structures.	BT-3	Application
14.	With an example explain how base isolators works.	BT-3	Application
15.	List the types of dampers and explain any two in detail with neat sketches.	BT-3	Application
16.	Explain the important points in mitigating the effects of earthquake on structures.	BT-3	Application
17.	Explain the applications of base isolation.	BT-3	Application

PART - C

1.	Demonstrate case study on application of seismic dampers.	BT-3	Application
2.	Discuss the construction procedure for base isolation techniques.	BT-3	Application
3.	Compose a case study on working principle of base isolator in Gujarat hospitals during 2005.	BT-3	Application
4.	Analyse the application of tuned mass damper in a high rise residential building.	BT-3	Application
5.	Why base isolation is effective in earthquake resistant design? Explain the effectiveness in multistory buildings.	BT-3	Application