30.11.11

Bengal Engineering and Science University Shibpur
Department of Architecture, T & RP
7th Semester Examinations 2011-2012

DISASTER RESISTANT ARCHITECTURE AR 701

Full marks: 70 **Time: 3hrs**

Answer **Question 1 (i-xx)** (10 marks) and **any 4** (4 x 15=60 marks) from the rest.

I Fill in the blanks or choose the correct answer from the options given.

i. _____occurs when loose, sandy soil acts more like a fluid than a solid.
a. Tsunami b. Liquefaction c. Resonance d. Subduction

ii. Three effects an earthquake can have on the natural environment that can cause tremendous damage are:
a. faults, landslides, and damping b. liquefaction, drift, and tsunamis
c. liquefaction, landslides, and tsunamis d. faults, seiche, and damping

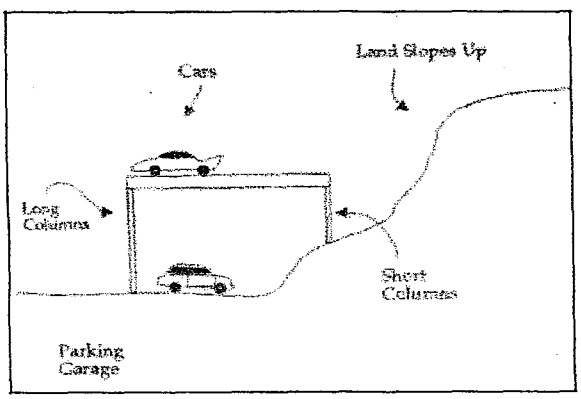
iii. The pendulum of a clock demonstrates the tendency of an object to swing back and forth in its natural _____
a. resonance b. ductility c. period d. torsion

iv. If the period of the ground movement and a building are the same, what results?
a. Resonance b. Ductility c. Period d. Torsion

v. The quality of partitions, ceilings, and other nonstructural elements of a building that make it a less efficient vibrator is called:
a. stiffness. b. ductility. c. damping. d. torsion.

vi. Steel has the ability to absorb energy and distort, rather than suddenly break like a more brittle material. This quality is called:
a. stiffness. b. ductility. c. damping. d. torsion.

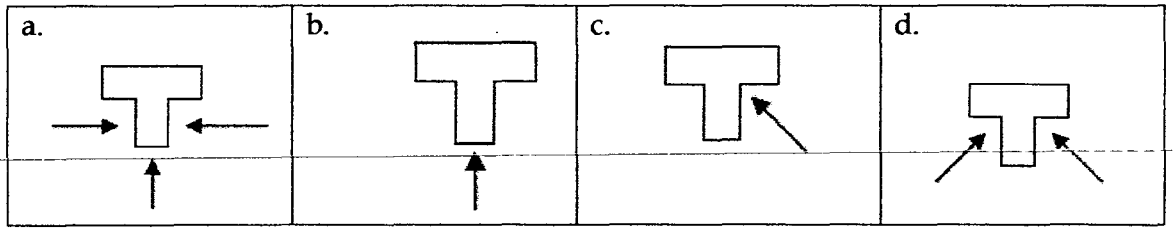
vii. What could happen to the building shown below in an earthquake?



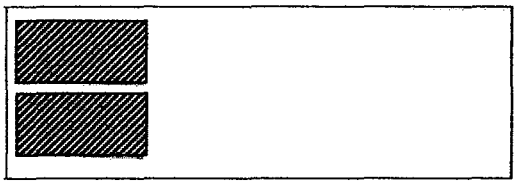
a. Nothing. This is a very strong structure that could withstand a high degree of ground shaking.
b. The longer columns in the front of the structure would receive more of the lateral load and if not properly designed would crack and collapse.
c. The shorter columns in the back of the structure would receive more of the lateral load and if not properly designed would crack and collapse.
d. It is hard to say without knowing the composition of the soil.

viii. Horizontal swaying of a building is called:
a. torsion. b. drift. c. ductility. d. tectonics.

ix. Select the location on a T-shaped building that would suffer the greatest stress during an earthquake.

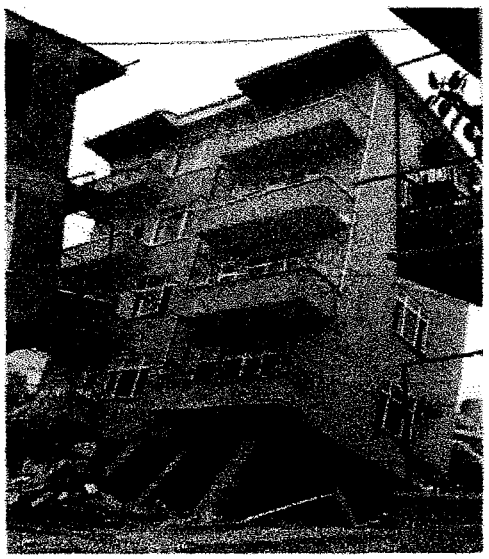


x. This illustration shows a building with a stiff elevator core placed at one end. During an earthquake, the free end of the building attempted to rotate around the stiff off-center elevator core. This is an example of what type of force?



a. Velocity b. Acceleration c. Torsional d. Symmetrical

xi. What type of structural design problem does the building below demonstrate?



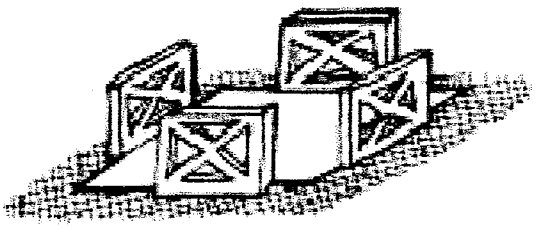
a. Soft-story
b. Irregular configuration
c. Non uniform mass distribution
d. Interruption of vertical elements

xii. The horizontal force at the base of a building created by an earthquake is often referred to as:
a. torsional force b. acceleration rate c. base shear d. force of gravity

xiii. Diaphragms are the _____ of a building.
a. shear wall system b. lateral bracing systems
c. floor and roof systems d. dual system

xiv. Buildings resist earthquake forces with basic structural systems, such as:
a. diaphragms.
b. horizontal bracing systems (shear walls, braced frames, and moment-resistant systems).
c. floors and walls.
d. all of the above.

xv. This illustration is an example of what type of horizontal bracing system?



a. Shear wall b. Braced frame c. Moment-resistant system d. Dual

xvi. Houses with many interior walls are a good example of what type of horizontal bracing system?

a. Shear wall b. Braced frame c. Moment-resistant system d. Dual

xvii. What makes up the built environment?

a. Buildings only
b. Buildings and bridges
c. Buildings, bridges, and water lines
d. Buildings, transportation lines and structures, communications lines, and utilities

xviii. Secondary effects caused by an earthquake do more damage than the damage done by ground motion.

a. This statement is never true.
b. This statement is always true.
c. This statement is sometimes true.
d. This statement was true 100 years ago.

xix. Which of the following building types perform well in earthquake?

a. Flat Slab building
b. Thin Slab building
c. Building with precast slab
d. None of the above

xx. Which of the following is good for earthquake resistance?

a. Large openings
b. Openings (door/window) very close to corners
c. A wall with large dimensions
d. None of the above.

[0.5x20=10]

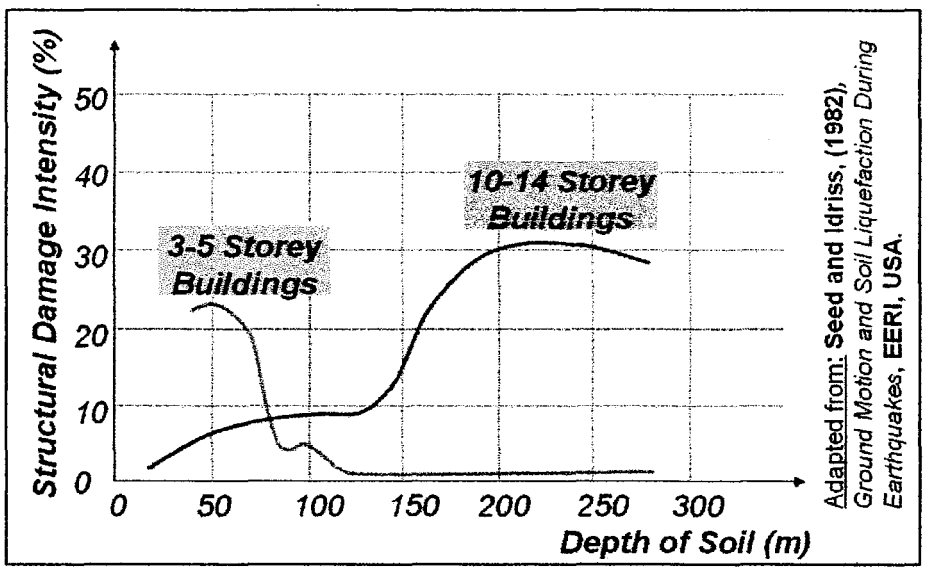
2i. How do design codes balance two conflicting requirements, namely, (1) protection of human lives by controlling damage in structures and (2) reduction of construction costs?

ii. Name the three main systems employed for resisting lateral loads.

iii. Consider a 10 storeyed building with an inter storey height of 3.5m. What is the allowable inter storey drift? Under real earthquake shaking conditions, what would be the actual maximum inter-storey drift for a building with ductile moment-resisting frames? Consider appropriate Response Reduction Factor, R.

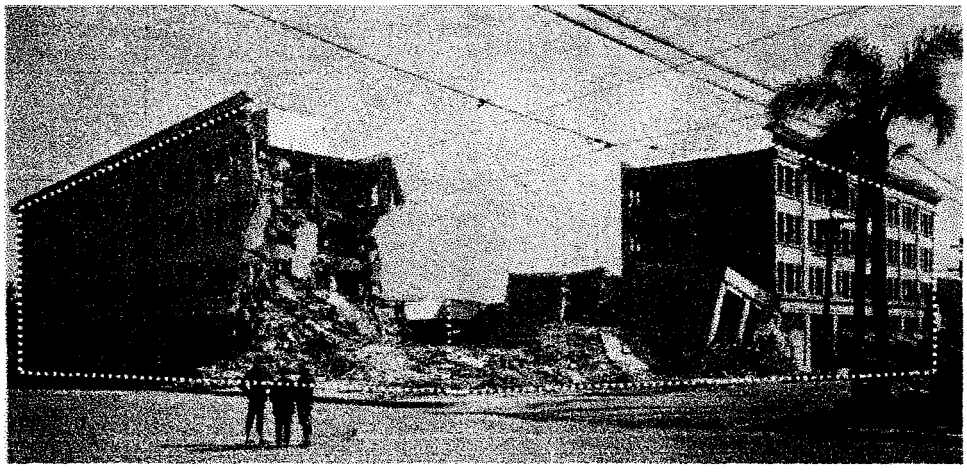
iv. Calculate the design base shear of a lifeline building in Zone IV on soft soil with a natural period of 0.3 seconds and ordinary shear walls. Consider Zone Factor, Importance Factor, Response Reduction Factor as appropriate. Consider Spectral Acceleration Coefficient=2.5. [5+2+4+4=15]

3i. Shaking intensities in an earthquake depend on a number of factors, including geological conditions and several others. The graph below shows the structural damage intensities of two categories of buildings plotted against type of underlying soil in the 1967 Caracas Earthquake. Give an analysis of the inferences from the graph. **[3]**

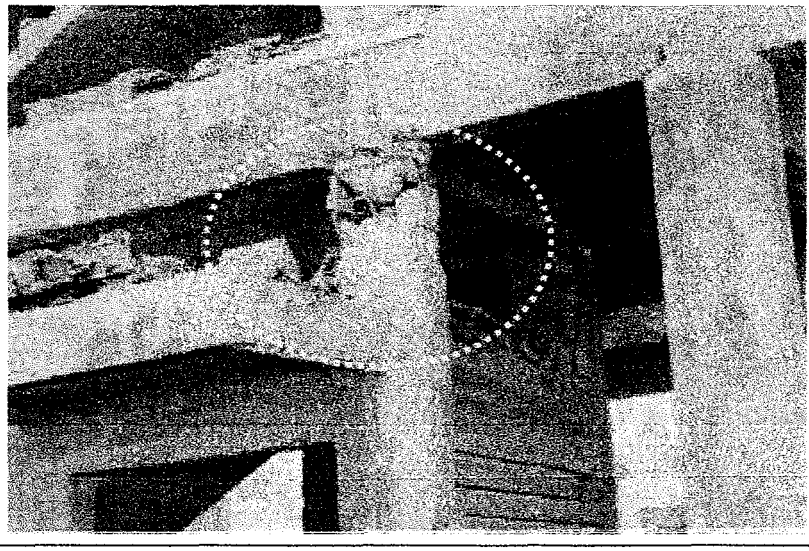


ii. The pictures below show some common seismic deficiencies of buildings of different typologies. For each case, identify the vulnerability/good practice, with a brief explanatory note justifying your answer. **[6x2=12]**

a



b.



4i. List three architectural aspects of shear walls with respect to their location in a building plan.

ii. What is the importance of boundary elements in a shear wall system? What are the different ways of designing these boundary elements?

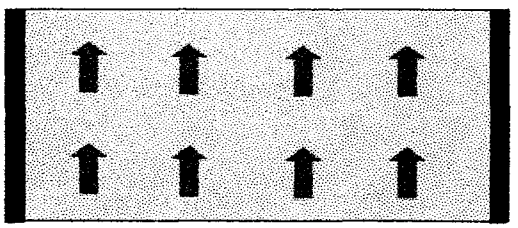
iii. How should the location of openings be planned in shear walls in a multi-storeyed building?

iv. What are coupled shear walls? What special considerations should be taken in the design of this structural system?

[3+4+3+5=15]

5i. What are diaphragms? [2]

ii. Study the plan of a diaphragm given below and answer the questions that follow:



a. What do the black arrows indicate? [1]

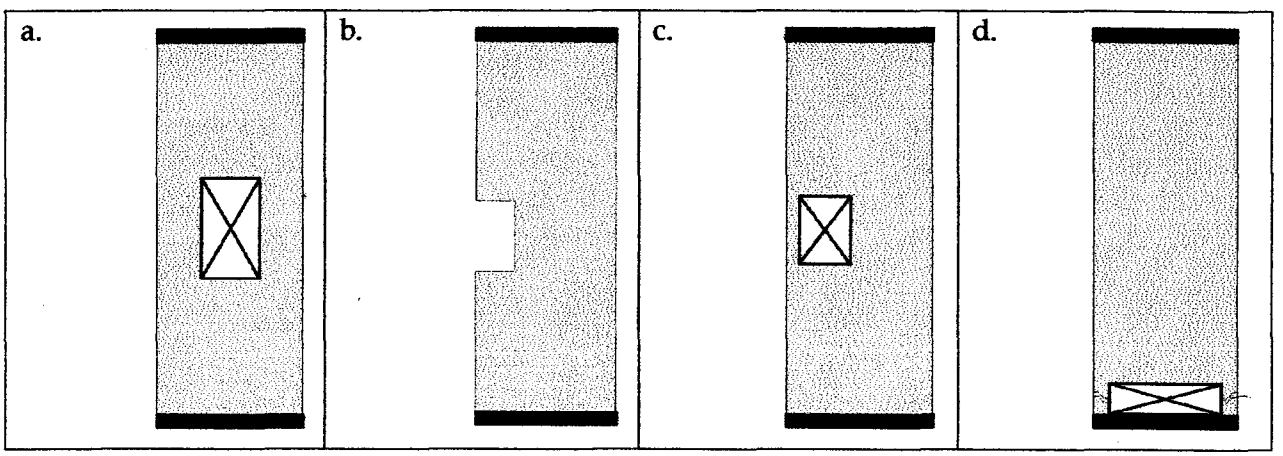
b. Label the lateral load resisting system in the y direction. [1]

c. Show the direction of resistance offered by the lateral load resisting system. [1]

d. Show the direction of ground shaking. [1]

e. Draw the deflection, bending moment and shear force diagrams [3]

iii. Referring to the diagrams drawn in ii(e) above, explain clearly advantages and disadvantages of different locations of penetrations in diaphragms as shown in figures a-d below. [1.5x4=6]



6a. What precautions need to be taken in designing buildings with cantilever projections to ensure good earthquake performance? [3]

b. Under what circumstances do unreinforced masonry infill walls (1) damage primary structural elements in a RC frame building with unreinforced masonry infills and (2) cause torsional effects? [3+3=6]

c. Explain two reasons for addressing the earthquake performance of staircases. [3+3=6]