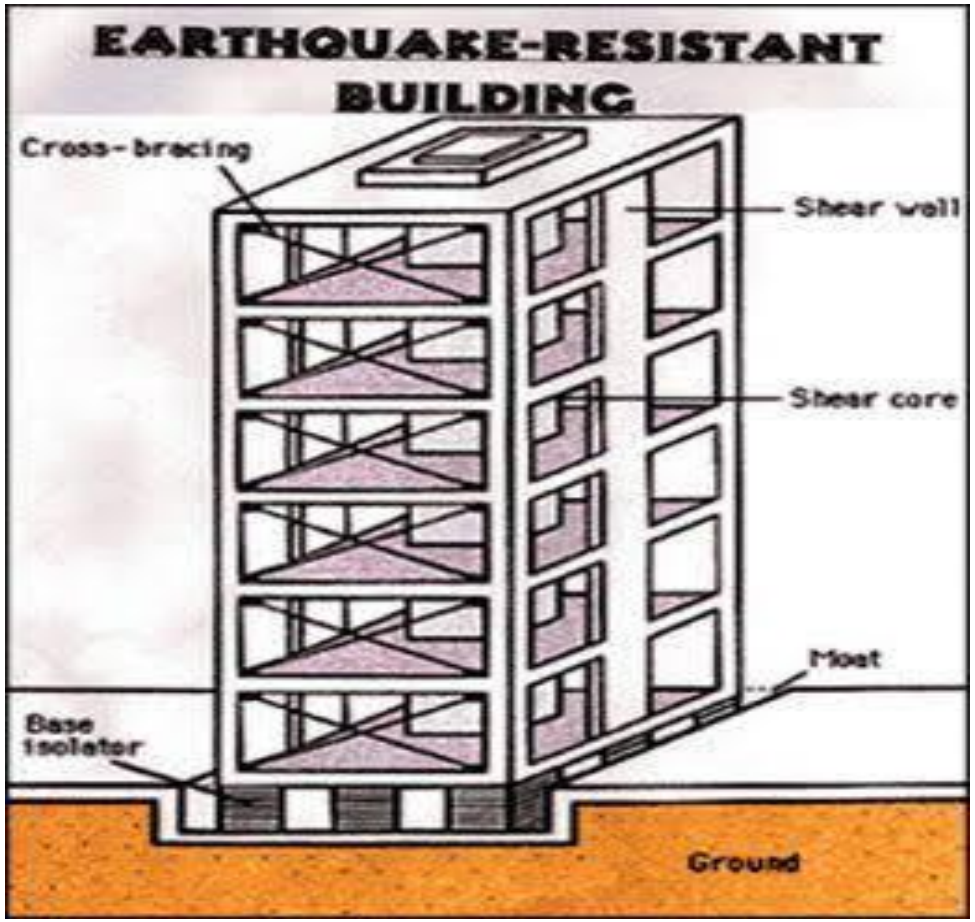
EARTHQUAKE RESISTANT BUILDING CONSTRUCTION



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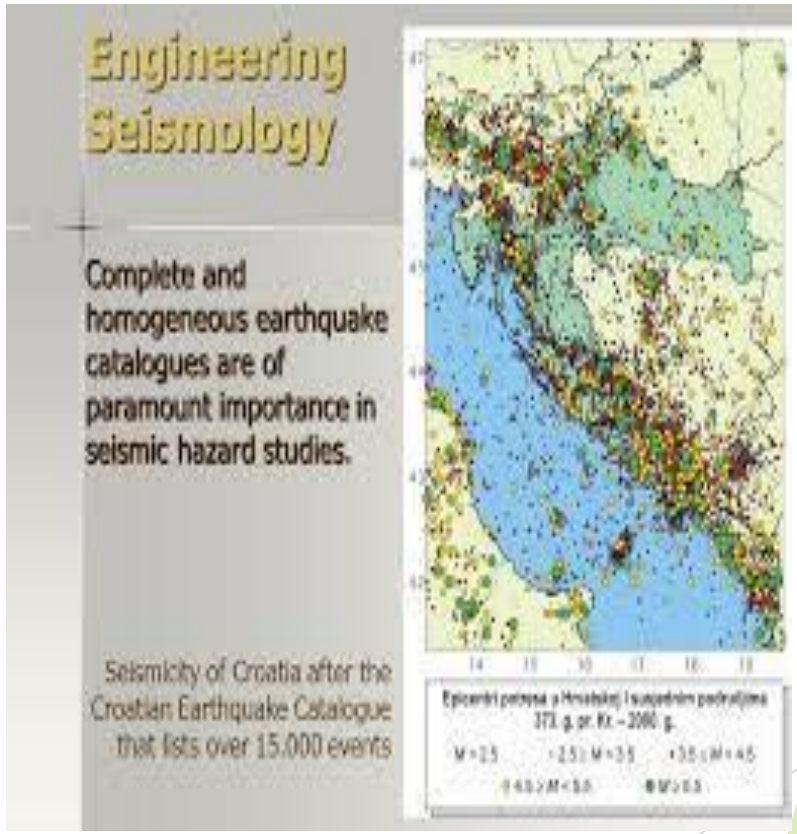
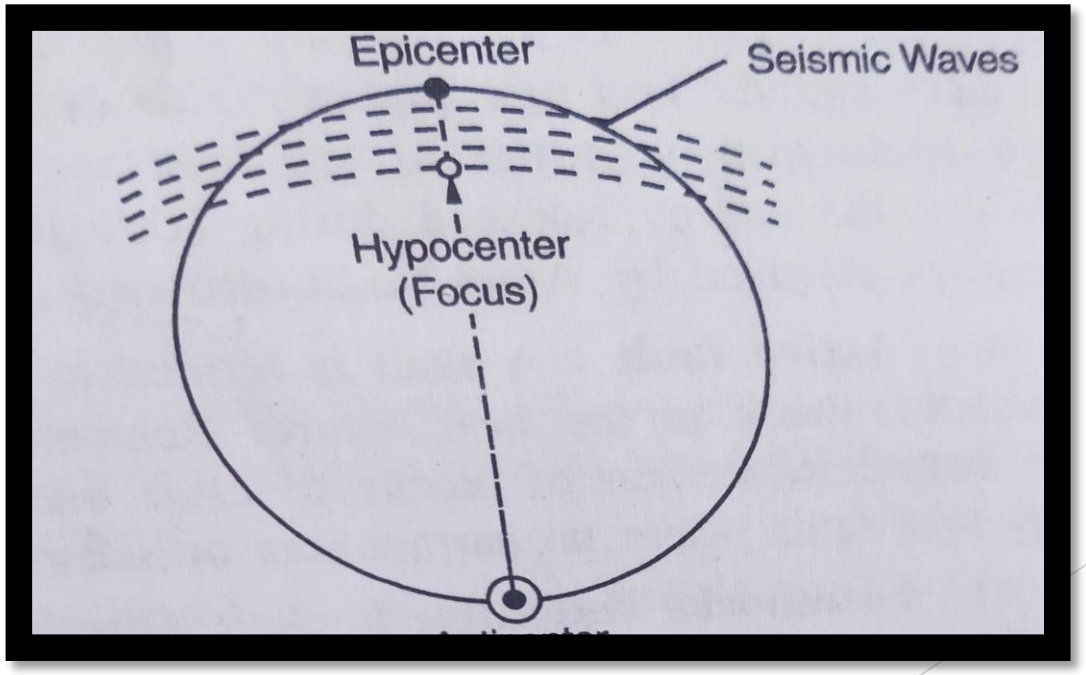


ELEMENTS OF ENGINEERING SEISMOLOGY

- ***Earthquake-*** the ground vibrations both feeble and strong produced on the surface of the Earth due to any reason whatsoever are described as **earthquakes**

1. **Anti centre**
2. **Seismic waves**
3. **Seismograph**

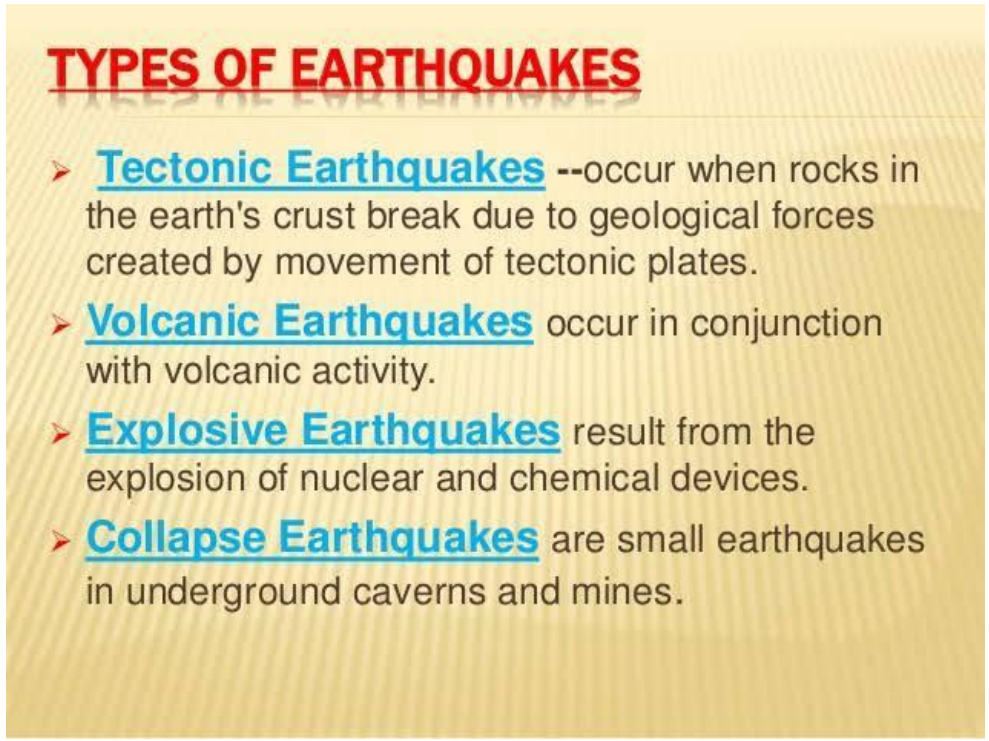


CAUSES OF EARTHQUAKES

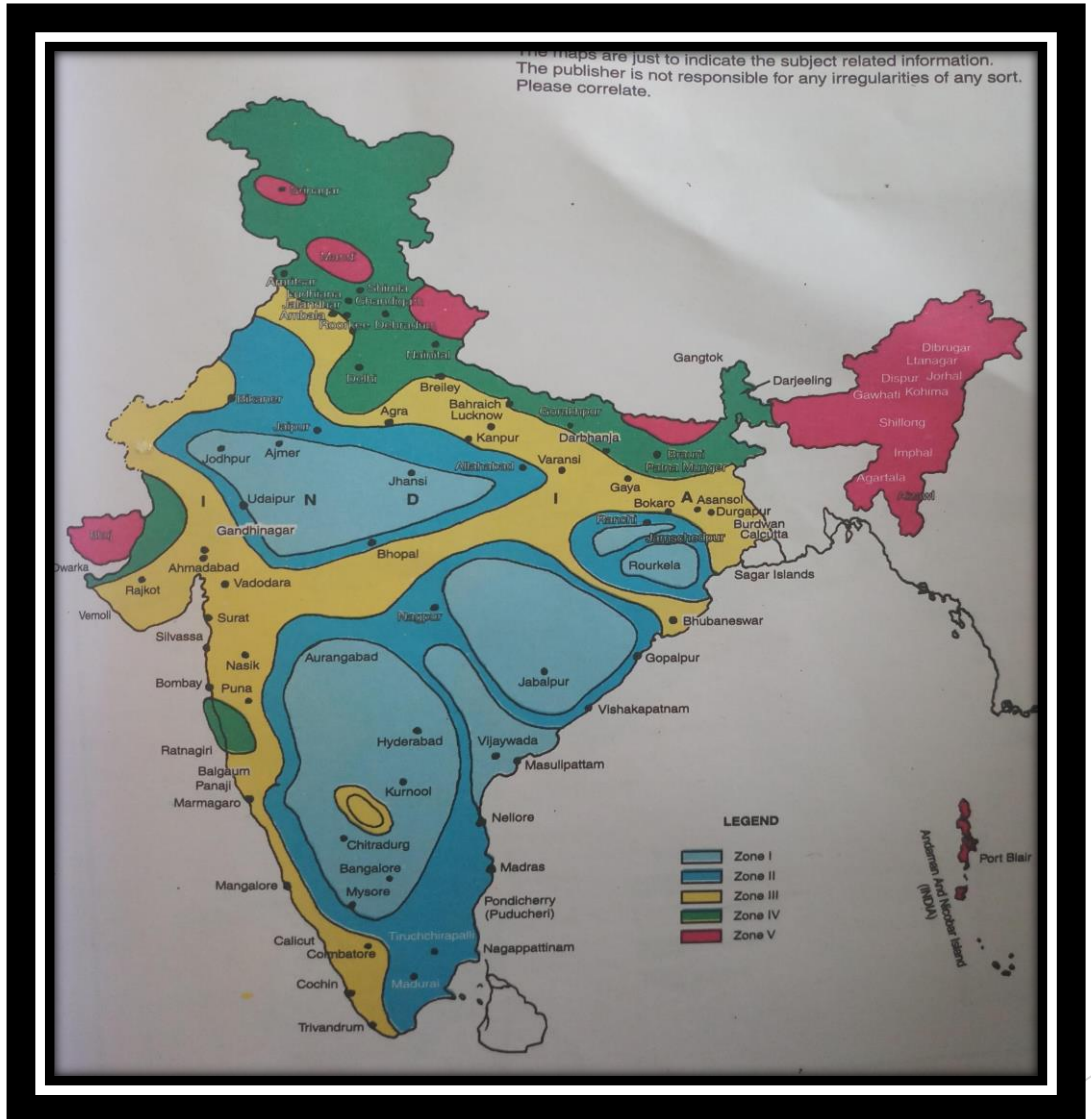
1. Superficial or surface causes
2. Volcanic causes
3. Tectonic causes

SIFICATION OF EARTHQUAKES

- On the basis of location
- On the basis of their cause
- On the basis of focal depth
- On the basis of intensity/magnitude



INDIAN SEISMIC ZONE MAP



SEISMIC BEHAVIOUR OF TRADITIONALLY BUILT CONSTRUCTIONS OF INDIA

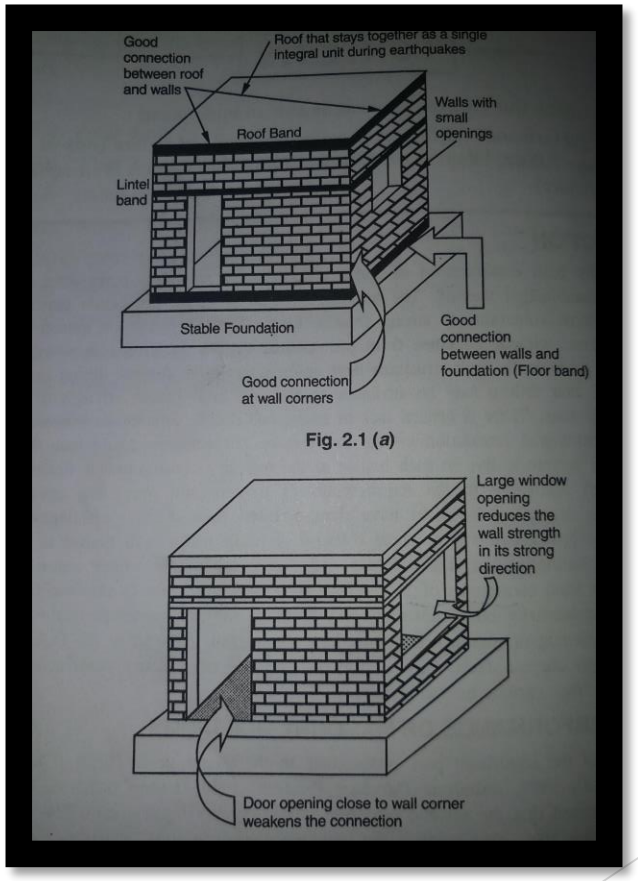
- **Introduction-**

Traditionally built constructions of India include small structure constructed in brickstone word for combination therefore the masonry buildings which are brittle structure have proved to be the most vulnerable to strong seismic forces

Major casualities which occurred during earthquakes such as Bhuj earthquake in 2001

SEISMIC PERFORMANCE OF MASONRY BUILDINGS

1. Failure of connection between walls
2. Absence of proper bonding between perpendicular walls at the junction
3. Large size of openings



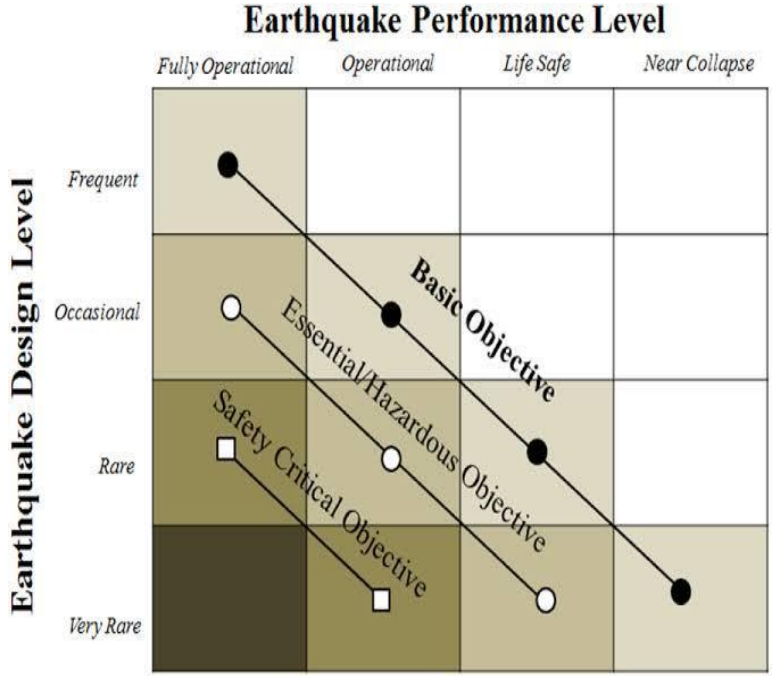
COMMON MODES OF FALIURE

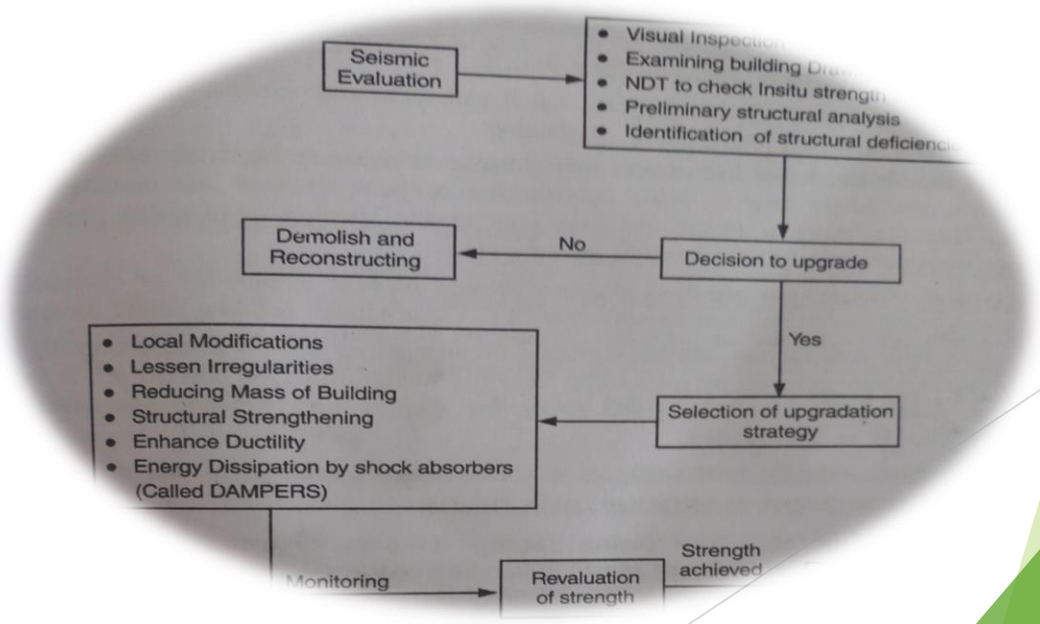
1. Out of plain failure
2. In-plain faliure
3. Diaphragm failure
4. Connection failure
5. Non-structural components failure

AVAILABLE SEISMIC RESISTANCE (ASR)

- CONDITION:-

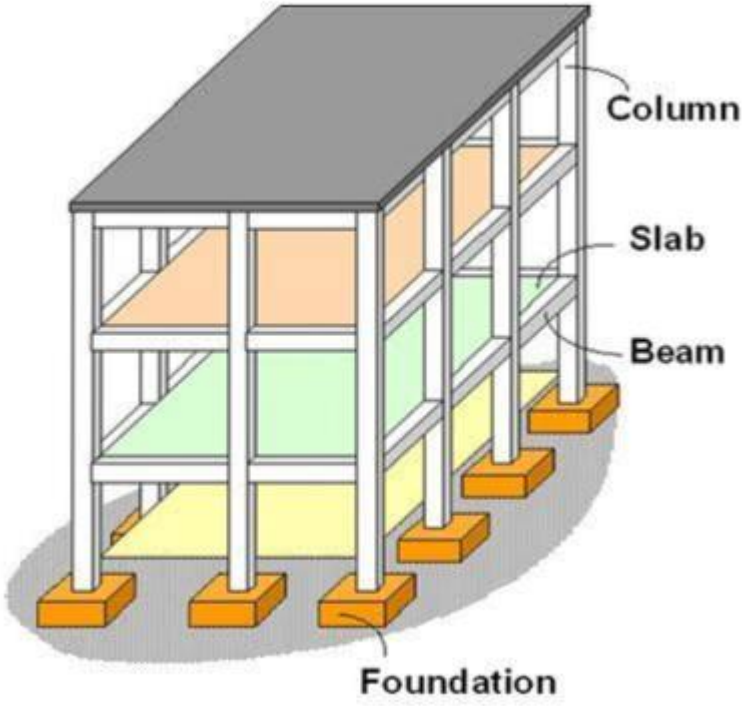
  (ASR) <(MSR) → SEISMICALLY WEAK STRUCTURE LIABLE TO BE DAMAGED DURING EARTHQUAKE





COMMON MODES OF REINFORCED CONCRETE BUILDINGS

1. Horizontal and vertical irregularitles
2. Identification of Seismic damages in building components
3. Columns beams slabs infill walls foundations
4. Ductile detailing as per IS:13920.1993.



TYPES OF IRREGULARITIES

- Vertical irregularities

1. Change in geometry
2. Change in strength
3. Change in stiffness
4. Concentration of mass

- Horizontal irregularities

1. Excessive lateral deflection
2. Non parallel shear walls
3. large openings in diaphragm
4. Lack of separation

DAMAGES IN COLUMNS

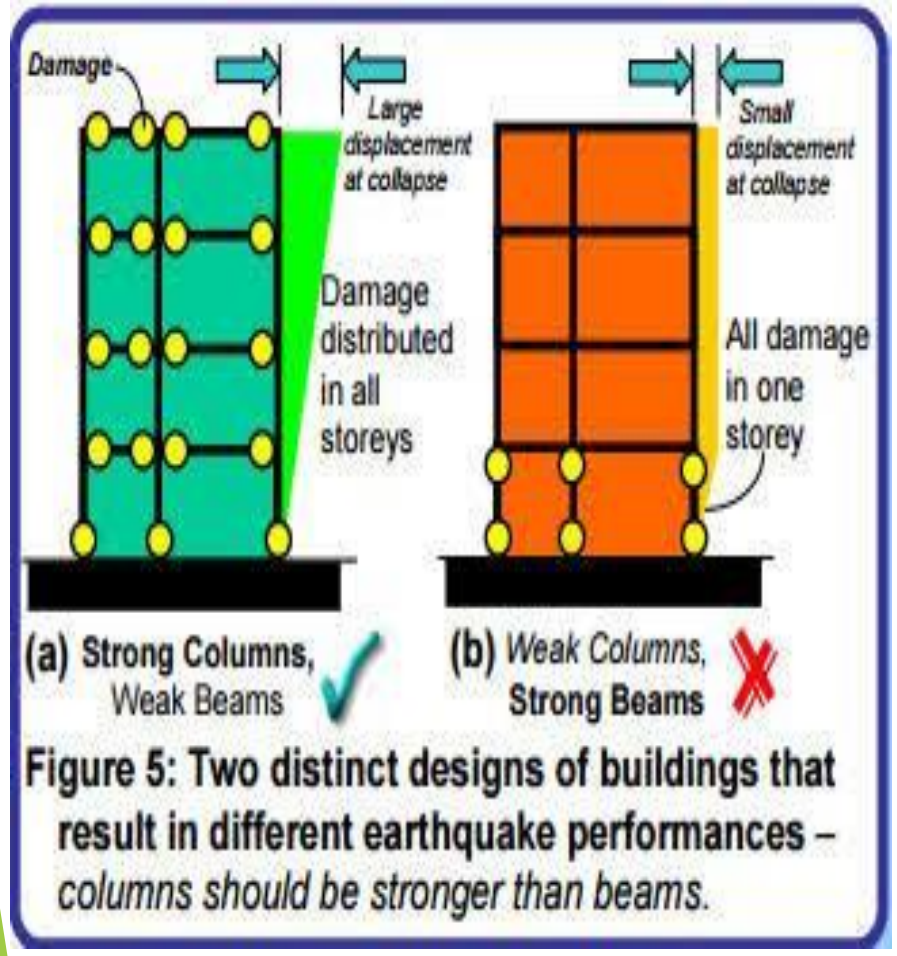


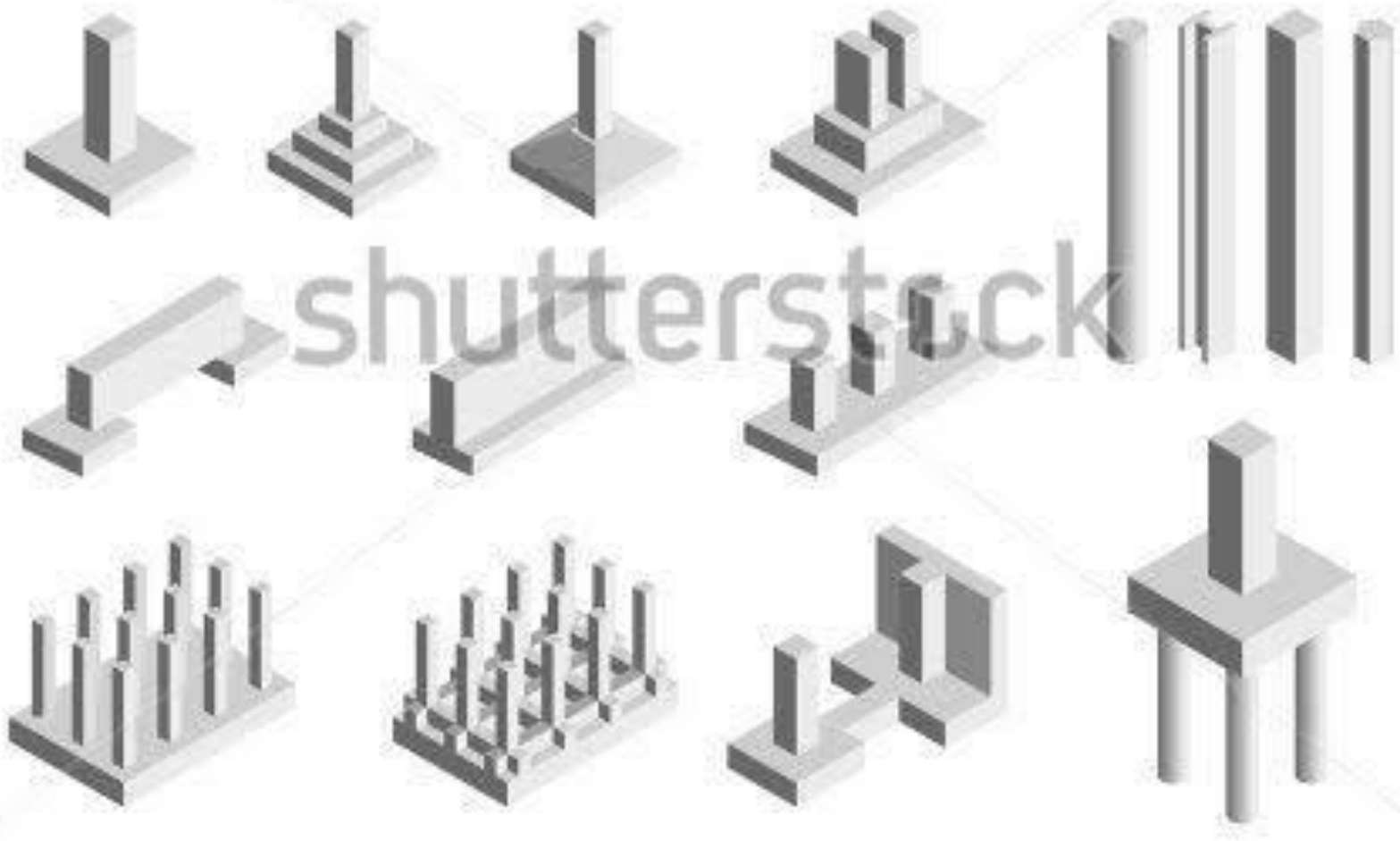
Figure 5: Two distinct designs of buildings that result in different earthquake performances – *columns should be stronger than beams.*

TYPES OF FOUNDATION

- Shallow Foundation
- Combined footing
- Mat foundation
- Pile foundation

TYPES OF FOUNDATIONS

SET 5: ISOMETRIC



IS : 1893 (PART-1) : 2002

Table 8 Percentage of Imposed Load to be Considered in Seismic Weight Calculation
(Clause 7.3.1)

Imposed Uniformly Distributed Floor Loads (kN/ m²)	Percentage of Imposed Load
(1)	(2)
Upto and including 3.0	25
Above 3.0	50

7.5 Design Lateral Force

7.5.1 Buildings and portions thereof shall be designed and constructed, to resist the effects of design lateral force specified in 7.5.3 as a minimum.

7.5.2 The design lateral force shall first be computed for the building as a whole. This design lateral force shall then be distributed to the various floor levels. The overall design seismic force thus obtained at each floor level, shall then be distributed to individual lateral load resisting elements depending on the floor diaphragm action.

7.5.3 *Design Seismic Base Shear*

The total design lateral force or design seismic base shear (V_B) along any principal direction shall be determined by the following expression:

$$V_B = A_h W$$

where

A_h = Design horizontal acceleration spectrum value as per 6.4.2, using the fundamental natural period T_a as per 7.6 in the considered direction of vibration; and

W = Seismic weight of the building as per 7.4.2.

7.6 Fundamental Natural Period

7.6.1 The approximate fundamental natural period of vibration (T_a), in seconds, of a moment-resisting frame building without brick infil panels may be estimated by the empirical expression:

$T_a = 0.075\, h^{0.75}$ for RC frame building

$= 0.085\, h^{0.75}$ for steel frame building

where

h = Height of building, in m. This excludes the basement storeys, where basement walls are connected with the ground floor deck or fitted between the building columns. But, it includes the basement storeys, when they are not so connected.

7.6.2 The approximate fundamental natural period of vibration (T_a), in seconds, of all other buildings, including moment-resisting frame buildings with brick infil panels, may be estimated by the empirical expression:

$$T_a = \frac{0.09}{\sqrt{d}}$$

where

h = Height of building, in m, as defined in 7.6.1; and

d = Base dimension of the building at the plinth level, in m, along the considered direction of the lateral force.

7.7 Distribution of Design Force

7.7.1 *Vertical Distribution of Base Shear to Different Floor Levels*

The design base shear (V_B) computed in 7.5.3 shall be distributed along the height of the building as per the following expression:

$$Q_i = V_B \frac{W_i h_i^2}{\sum_{j=1}^{n} W_j h_j^2}$$

where

Q_i = Design lateral force at floor i,

W_i = Seismic weight of floor i,

h_i = Height of floor i measured from base, and

n = Number of storeys in the building is the number of levels at which the masses are located.

7.7.2 *Distribution of Horizontal Design Lateral Force to Different Lateral Force Resisting Elements*

7.7.2.1 In case of buildings whose floors are capable of providing rigid horizontal diaphragm action, the total shear in any horizontal plane shall be distributed to the various vertical elements of lateral force resisting system, assuming the floors to be infinitely rigid in the horizontal plane.

7.7.2.2 In case of building whose floor diaphragms can not be treated as infinitely rigid in their own plane, the lateral shear at each floor shall be distributed to the vertical elements resisting the lateral forces, considering the in-plane flexibility of the diaphragms.

NOTES

1 A floor diaphragm shall be considered to be flexible, if it deforms such that the maximum lateral displacement measured from the chord of the deformed shape at any point of the diaphragm is more than 1.5 times the average displacement of the entire diaphragm.

TYPES OF DISASTERS

- Major natural Disasters

1. Earthquake
2. Cyclone
3. Drought
4. flood

- Minor natural Disasters

1. Setting of fires
2. epidemics
3. deforestation
4. pollution

DISASTERS